

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1910.

GENERAL PHYSICS

1180. *An Absolute Manometer.* M. Knudsen. (Ann. d. Physik, 32, 4, pp. 809-842, June 21, 1910.)—The repulsive force, K , exerted by each cm^2 of two parallel plates at absolute temps. T_1 and T_2 is related to the pressure p of the surrounding gas or vapour by the equation $p = 2K/(\sqrt{T_1/T_2} - 1)$ dynes per cm^2 . This expression was tested by means of an apparatus consisting of a vertical Pt strip set parallel to a Pt plate suspended by a short wire. The strip was warmed electrically and its temperature determined by a resistance measurement, and the deflection of the suspended plate could be read off by means of a mirror and telescope; the apparatus was placed under a bell-jar connected with a Gaede pump and McLeod gauge. Readings of temperature and of the values of p are given along with those (p') obtained from the pressure gauge. From results for different gases it is taken that a manometer of the form mentioned can only be employed in measuring very small pressures. With increasing pressure, the value of p'/p increases continuously from unity. A more accurate determination of the repulsive force showed that, when the pressures were so great that the distance of the plates was equal to or greater than the mean free path of the gas molecule, this force is not related in a simple manner to the gas pressure and temperature. Other experiments are described, which show that the absolute manometer can be employed for measuring the pressure of mercury vapour. G. E. A.

1181. *An Electric Micromanometer.* J. Villey. (Comptes Rendus, 151, pp. 65-67, July 4, 1910.)—Special collodion having a small amount of salt dissolved in alcohol is stretched on a metal ring, thus forming one plate of a condenser. The other plate is a polished metal disc of the same size. This condenser is charged and is connected to a quadrant electrometer. If a small change of pressure occurs on one side of the collodion membrane the electrostatic attraction between the plates of the condenser changes, and is measured by the electrometer. This is less sensitive than a light-interference method would be, but is more convenient. P. E. S.

1182. *Anemometer registering separately the North and East Components of the Wind.* J. T. Morrison. (Roy. Soc. Edinburgh, Proc. 80. pp. 886-895, 1909-1910).—The wind sets in motion a wind-wheel, which is kept constantly facing the wind by a wind-vane. The recording part of the apparatus consists of a sphere mounted on a horizontal axis so as to be free to rotate round it. By suitably connecting the sphere with the wind-wheel, the sphere is caused to spin on the axis at a speed proportional to the speed of the wind, while the axis itself is connected with the wind-vane and so kept constantly facing the wind. The separation of the two components of the wind is made by two circular horizontal plates of equal size, which are free to rotate about vertical axes through their respective centres. These plates are brought up below the sphere so as to touch it lightly with their bevelled edges, the axis of one plate being due north of the centre of the sphere, that of the other being due east. With such an arrangement the angle turned through by the plate fixed to the north of the centre must be proportional to the northerly component of the "travel" of the wind. An ingenious recording apparatus is attached to the two discs, so that the instrument supplies two records similar to the velocity trace of a Robinson anemometer, which give respectively the N.-S. and E.-W. components of the wind. R. G. K. L.

1183. *Seismograph for Vertical Motion.* B. Galitzine. (Comptes Rendus, 150. pp. 1727-1731, June 27, 1910).—The author describes a new type of seismograph for measurement of the vertical component, and based on the same principles as his horizontal pendulums. A girder beam, carrying a mass of about 24 kg., is pivoted at one end on a horizontal axis, and maintained in the horizontal position by a strong steel spiral spring. The outer end carries a coil and a copper plate. These come between the poles of powerful permanent magnets, the former thus giving the galvanometer registration and the latter the magnetic damping. The author derives the formula for calculating the absolute vertical movement of the ground from the galvanometer reading. Tests were made to find the accuracy of the apparatus. The instrument was placed on a stand oscillating vertically through 0.101 mm. The values obtained for the amplitude varied from 0.101 to 0.111 mm., the average error being about 8 per cent. A. D. R.

1184. *Removal of Paraffin, Vaseline, &c.* C. Benedicks. (Phys. Zeitschr., 11. pp. 254-255, March 15, 1910).—The difficulty of removing paraffin oil, vaseline, &c., from a surface so that the latter can be uniformly wetted with water may be overcome by washing with condensing alcohol vapour. Thus, the interior of a beaker may be freed from paraffin oil by inverting the beaker over a similar one containing a little alcohol and placed on a water-bath. This method gives good results when applied to the removal of grease from the fractured surface of steel, from articles to be silvered, &c. T. H. P.

1185. *Strength of Steel I-Beams.* E. L. Hancock. (Eng. Record, 62. pp. 48-49, July 9, 1910. Paper read before the Amer. Soc. for Testing Materials, June 28, 1910).—Tests were made on pieces cut from standard I-beams varying in size. Specimens were cut from middle of web, root of the web, and the flange near the root. These were carefully prepared and finished by draw-filing. The reduced section was long enough to admit of use of extensometer on 8-in. gauge length. Extensometer readings appear to have been taken in four planes. The conclusions to be drawn from tests are: (1) The elastic limit varies considerably for material cut from different

portions of the beam, being lowest in root of web, higher in flange near root, and highest in web [this confirms work of Marburg]; (2) there appears to be considerable difference chemically in different parts of the beam; (3) the appearance of fractured pieces indicates variation in density of material throughout the beam, due probably to the work of rolling the beams. Microphotographs were taken: the web shows the finest structure, the flange next, while the root is much coarser. C. A. M. S.

1186. *Repeated and Eccentric Load Tests on Reinforced Concrete Columns.* M. O. Withey. (Eng. Record, 62, pp. 51-58, July 9, 1910. Paper read before the Amer. Soc. for Testing Materials, June 30, 1910.)—Contains results obtained from tests of 12 very strong, spirally reinforced concrete columns. In making the columns the longitudinal rods were spaced at equal distances apart and wired to the inner circumference of the spiral. An attempt was made to obtain measurements of strains so as to accurately compute deformations at various points in the cross-section of column. Among the conclusions drawn are the following: (1) Rich mixtures are advantageous, a point emphasised by the great strength and stiffness of many of the columns. (2) A large percentage of either longitudinal or spiral reinforcements is unnecessary with centrally loaded columns. (3) Longitudinal steel in larger amounts is of more advantage in eccentrically loaded columns. (4) From tables and figures it is seen that there was practically no increase in deformation after a few repetitions of loads equal to 40 or 50 per cent. of the yield-points of columns tested. (5) Additional strength and toughness is afforded by the spiral after the yield-point of longitudinal steel has been passed, but the additional strength is probably not permanent. (6) The formula $S = P/A \pm Mc/I$ commonly used for short homogeneous columns eccentrically loaded may be applied to reinforced concrete columns if suitable allowance is made for the steel. C. A. M. S.

1187. *Further Tests of Brittle Materials under Combined Stress.* W. A. Scoble. (Phil. Mag. 19, pp. 908-916, June, 1910.)—The author discusses the three theories of elastic strength. He refers to tests on ductile materials and his previous tests on cast-iron bars under combined stress [see Abstract No. 495 (1910)]. All of the evidence shows that shear stress causes elastic failure for ductile materials, while the principal stress appears to be the cause of fracture with cast iron. Cast iron is, however, somewhat unsuitable. The paper gives results of tests made on cast steel containing 0.7 per cent. carbon. The bars used were hardened and subjected to combined twisting and bending. Curves show that, up to point of fracture, the material was elastic. Results of several tests show that the max. principal stress is approximately constant, but the author considers it is not easy to determine whether the value of this principal stress at fracture depends on the least principal stress. If the max. principal stress were constant at rupture, the points for a bar would lie on an ellipse. Three such mean curves have been drawn, one for each group of specimens. Considering the difficulties in making the tests, the points lie fairly evenly about the curves. On bar No. 1 three tests were made; the max. principal stresses were 82,060, 72,000, 86,850. On bar No. 9 these stresses were 98,200, 76,400, and 83,900. For bar No. 2 the values were 120,200 and 113,000. For bar No. 11 the values were 53,850 and 47,500. The max. shear stress showed a much greater variation. Angles of fracture were measured and agreed with those of planes of max. stress even better than those obtained in the

earlier tests on cast iron. As an example, the angles for the pure torsion tests may be quoted. The correct angle is 45° . Those actually recorded were 43, 46, 44, 44, and 44° . The angles of fracture were wonderfully clean, and as true as though the edges had been cut with a tool. An interesting comparison of the strength of the bars before and after hardening is made. Although none of the actual bars were tested unhardened, yet other steel bars, of exactly the same size, yielded at 2400 lb.-inches torque, or 2660 lb.-inches bending moment. It appears that when the bars are made very hard, the bending moment which they are capable of withstanding without fracturing is slightly greater than at yield in the unhardened condition. Sometimes the strength to resist bending is diminished by the quenching. Similarly, as an average result, it may be stated that a hardened bar can withstand about double the torque which could cause it to yield when in the ductile state. C. A. M. S.

1188. *Electrical Resistance and other Physical Properties of Building Materials.* W. R. Baldwin-Wiseman and O. W. Griffith. (Inst. Civ. Engin., Proc. 179, pp. 290-312, 1909-1910.)—The experiments were conducted upon various building-stones. Tables are given showing the sp. gr., density, and porosity of the stones tested; also of the crushing strength, dried and soaked; strength after subjection to high temperatures; effect of increased period of exposure and increased temperature on strength; linear coefficients of expansion, permanent elongation and specific heats; stress caused in component of a composite building by a rise in temperature; thermal conductivities. Finally the electrical resistance of the various stones is shown in the table here reproduced in part:—

Stone.	Specific Resistance per Centimetre Cube.			Resistance per Foot Cube of Wet Stone.
	Dry Stone.	Stone separately (Wet).	Assumed Water Path.	
	Ohms $\times 10^6$. From	Ohms $\times 10^6$.	Ohms $\times 10^6$.	Ohms.
Yorkstone.....	10	20.02	2.4	660
Red Mansfield.....		17.88	2.7	690
Quartzite.....		436.7	1.8	1480
Hard Daresbury.....		85.4	6.2	1160
Douling stone.....		48.6	6.8	1420
Portland base bed.....		26.7	8.4	870
Bradford oolite.....		40.0	8.8	1810
Bath oolite.....		28.6	4.98	980
Marble, Carrara.....		258.0	2.1	8450
Rouge Royal.....		858.0	8.8	1160
St. Anne's.....		541.0	4.0	1770
Dove.....		894.0	8.8	1250
Black.....	1000 +	147.0	1.1	4790
Belgian granite.....		307.0	8.2	1000
Red granite.....		871.0	1.04	1910
Diabase.....		1670.0	4.00	5460

L. H. W.

1189. *Internal Friction of Metals at Low Temperatures.* C. E. Guye and H. Schapper. (Comptes Rendus, 150, pp. 962-964, April 18, 1910.)—The

authors give the results of measurements of the internal friction of the metals Cu, Zn, Au, Ni, Pd, and Pt at temperatures varying from 100° to -195° by the torsion pendulum method [compare Abstract No. 224 (1910)]. The viscosities of Zn and Cu decrease with fall of temperature, like that of Ag, whilst with Au the viscosity exhibits a marked increase as the temperature changes from -80° to -195° . With Ni, Pd, and Pt the values obtained are small, but in the case of Pt a higher viscosity was always obtained in the range 0° to -90° than at 100° to -195° . T. H. P.

1190. *Pressure on Aeroplane Surfaces.* R. Soreau. (Comptes Rendus, 180. pp. 1595-1598, June 18, 1910.)—If F is the component of the force normal to the general displacement, and H the component parallel to it, the equations $F = KSV^2a$ and $H = KSV^2(va^2 + s)$ have been put forward by the author, where $a = i + \gamma$, i being the inclination of the chord and γ an angle characteristic of each surface, and zero for a plane surface. The author works out new and somewhat more complex formulae with the aid of the theorem of momenta, the air being regarded as flowing along filaments making certain angles with the surface. E. E. F.

1191. *Discharge over Broad-crested Weir.* A. H. Gibson. (Phil. Mag. 20. pp. 95-96, July, 1910.)—Assuming the velocity in the surface, and at every point in the stream above the weir, to be given by $\sqrt{2g(H-i)}$ ft. per sec., where H is the up-stream head measured above the crest, and i the thickness of the stream, then the discharge is given by $Q = \delta t \sqrt{2g(H-i)}$ cub. ft. per sec., where δ is the breadth of the stream. Since the stream will adjust itself so as to give max. discharge under given conditions, i can be determined by equating dQ/di to zero. Hence $i = \frac{1}{3}H$ and $Q = 0.885 \delta (2g)^{\frac{1}{2}} H^{\frac{3}{2}}$ cub. ft. per sec. Writing this in the usual form $Q = \frac{1}{2} C b (2g)^{\frac{1}{2}} H^{\frac{3}{2}} = K b H^{\frac{3}{2}}$, we have $C = 0.578$ and $K = 8.087$. This treatment is more rational if account is taken of the fact that in a parallel stream flowing in an open channel the velocity is a maximum at or near the surface and a minimum at the bottom. Experiments show that the ratio of the mean velocity over the whole section of such a stream to the max. surface velocity lies between the limits 0.82 and 0.87 for such surfaces and depths as are common on the crests of such weirs, this ratio increasing with the depth of water. Assuming, as is practically the case, that the max. surface velocity is equal to $\sqrt{2g(H-i)}$, the mean velocity will equal $k \sqrt{2g(H-i)}$, and the discharge will be given by $k K b H^{\frac{3}{2}} = K' b H^{\frac{3}{2}}$ cub. ft. per sec. Corresponding to the values 0.82 and 0.87 for k , the values of K' become 2.58 and 2.69. The validity of this formula receives remarkable confirmation from the results of a large series of tests on such weirs, carried out in 1908 at Cornell University for the U.S. Geological Survey. A. W.

1192. *Turbulence in Liquid Stream.* L. Hopf. (Ann. d. Physik, 32. 4. pp. 777-808, June 21, 1910.)—Previous work by Reynolds, Lorentz, Kelvin, and others is first dealt with, and then a description is given of the research apparatus and method. The flow of liquid was observed for several sloping channels and tubes, and the results are tabulated and graphed. The ideal flow for small depths would be that in which the streaming follows a simple hydrodynamical law, conditioned by friction. For the flow in other cases (as in tubes, &c.), it is established to a first approximation that the flow is not always according to Reynolds' law, but is conditioned by the so-called

Reynolds' number $R = \rho v l / \mu$, where ρ is the density of the liquid, μ the friction coefficient, v the mean velocity, and l a linear measurement of the stream (as diam. of a tube, depth of stream, &c.). For small values of R the flow follows a simple hydrodynamical law, but for large values of R the so-called turbulent motion appears, which is characteristic of the "hydraulic" state. The transition from one state to the other takes place spontaneously and suddenly; it is shown by a sharp angle in the observation curve. In spite of the great uncertainty of measurements of the depth of the stream, the critical Reynolds' number R_c for which the transition from the hydrodynamic to the hydraulic state takes place, can be determined, by taking the average of a number of observations, to within a few per cent. For water it lies in the neighbourhood of 800. A dependence of the magnitude of R_c on material and roughness of the bottom of the channel could not be decided. Reynolds' law holds good within the limits of accuracy of the experiments for variation of the slope of the channel, which is synonymous with a variation of the velocity or the depth. Reynolds' law is not true when different fluids, for which the friction is large, are used. Variations of R_c of as much as 25 per cent. were found for sugar solutions flowing down a smooth copper channel, while in the corresponding experiments in smooth glass tubes a difference in the critical numbers of only about 8 per cent. was observed. With a free surface for the liquid the variations tend to show that, other things being equal, the value of R_c decreases with increasing values of the friction coefficient. That such variations should occur is easy to explain theoretically, since in the critical case new characteristic numbers come into play, which is not the case when the flow is between fixed walls; moreover, capillarity has a great effect in the free surface, and this is quite neglected in the differential equations. The conditions are much complicated owing to the waves which appear on the free surface of the liquid. These are quite independent of the turbulence phenomenon, and hinder a direct observation of the turbulent motion by optical means. The laws which these surface waves obey differ considerably from those for waves in still water. A. W.

1193. *Flow of Water in Curved Pipes.* J. Eustice. (Roy. Soc., Proc. Ser. A, 84, pp. 107-118, July 8, 1910. Engineer, 110, pp. 23-24, July 1, 1910.)—In order to study the effect of change of curvature of the flow tube, experiments were made on the flow of water in flexible pressure-tubing with thick walls—a composite of rubber and canvas. The dimensions of the tube used were: External diam. = 0.81 cm., internal diam. = 0.8684 cm. For straight-tube flow, the flexible tube was laid on an inclined plane; for coiled-tube flow, the tube was coiled around cylinders; but in all the experiments the angle of the helix was kept constant. Two investigations were carried out, each consisting of several series of experiments: (1) *Coiled Tube*.—The determination of the combined effect of the variation in curvature of the length of the tube and of the form and area of section. (2) *Oval Tube*.—The determination of the effect of the variation in the form of section of the straight tube. From the table and diagrams of results it appears (a) that the flow in straight flexible tubes obeys the laws of flow in metal tubes as investigated by Reynolds. In Reynolds' experiments, at velocities below the critical velocity the flow is proportional to the velocity. In the author's experiments the flow is proportional to the n th power of the velocity when the tube was free, n varied from 1.18 to 1.2; when the tube was squeezed in a straight groove, n became 1.08 to 1.04. This discrepancy is accounted for, since it is shown that n curvature of the tube length increases the value of n ; the flexible tube when not con-

finer in a groove was sinuous, and this sinuosity increases n . In other experiments on metal tubes, the author found that whilst $n=1$ for straight tubes, the effect of introducing angle bends in the tube length is to increase n to 1.1. The curves given illustrate a peculiarity observed by Reynolds. The critical velocity region is different for experiments at gradually increasing velocity and for experiments at gradually decreasing velocity. (b) The critical velocity region is present in all the squeezed-tube experiments, even when the tube is flattened sufficiently to reduce the area to less than one-half the original area. The flow obeys the index law, both below and above the critical velocity; i.e., in the logarithmic plotting the lines below and above the critical velocity are both straight. In all the coiled-tube experiments, on the other hand, the value of the index n gradually increases with the velocity of flow, and there is an entire absence of the critical velocity region. The lines in the logarithmic curves have a gradually increasing slope from the low velocities to the higher velocities of flow. The experiments show conclusively that this absence of the critical velocity region is not due to the variation in sectional form or area. (c) The increased resistance expressed in terms of the loss in quantity (Q) discharged, or in loss of velocity (V) for a given loss of pressure is given approximately by the formula $[\Delta Q/Q]^2 = [\Delta V/V]^2 = CR^{-1}$, where C is a constant for a constant hydraulic gradient, and R is the radius of the tube. (d) The slow recovery of the flexible tube from the strain due to deformation caused by squeezing, or by coiling, adversely affected the experiments, but the time lag was not sufficiently serious to affect materially the general deductions which have been made. A. W.

1194. *Principles of Mechanics: Apparent Mass.* By J. BOUSSINESQ. (Comptes Rendus, 150, pp. 1699-1643, June, 20; 1721-1725, June, 27, and 151, pp. 5-10, July 4, 1910.)—The author develops the view that our equations of motion, &c., take their form through the elimination, justified by experience, of a multitude of true variables; and illustrates this by the theory of projectiles and the theory of elasticity. He shows how the idea of fictive or apparent density comes in in the theory of weighted strings, in that of a short pendulum in a liquid at rest, in that of the vibrations of a liquid surrounding an object at rest, in the theory of optical density and of double refraction. In the last case the differences in the optical density along the axes arise from differences in the power of resistance of the molecules of the crystal in different directions, and depend also on the velocity of the ether-displacements. Proceeding, he shows that in every movement of translation of a body in space, there is a similar conflict between matter and ether, and that the terms expressing this depend on the velocity and are not linear functions but increase in rapidly increasing ratios as the velocities increase beyond ordinary terrestrial or orbital velocities, and then take a form equivalent to rapidly increasing the mass of the body moving in the ether. In ordinary circumstances this supplementary inertia is insensible because, as the author works it out, of the extremely small density, the divisibility, and the penetrability of the ether and because of the impossibility of longitudinal vibrations, which, in his view of the ether as a particle-cloud, tend to become possible when the velocity becomes great. On the same view, a cathode-stream would bombard the whole of the ether-cloud opposed to it and would condense it so as to produce great resistances, equivalent to apparent increases in the inertia. In all this there would be nothing contrary to the principle of the constancy of mass. A. D.

1196. *A Steamship with Horizontal Corrugations along the Hull: Results of Tests.* A. H. Haver. (Eng. News, 63, p. 701, June 16, 1910. Paper read before the North-East Inst. of Engin. and Shipbuilders, Feb. 18, 1910.)—The tests made with a plain ship and the corrugated ship *Monitoria* showed a difference of 84 per cent. in the residuary resistance in favour of the corrugated ship. At the same speed and displacement the i.h.p. for the corrugated ship was 988, while the plain hull ship showed 1116 i.h.p.

1198. *Rigidity and Relativity.* T. Levi-Civita. (Ann. d. Physik, 82, 1, pp. 286-240, April 28, 1910.)—Relative rigidity may be expressed without giving up three-dimensional space by a consideration of the apparent changelessness of the system as seen by an observer moving with it. The definition of relative rigidity so obtained does not contain the postulate of symmetry, i.e., the equality of apparent lengths of an extended body as seen from its two ends. If it did, it would also involve the spatial homogeneity of the moving rigid body. From Herglotz's formula [Abstract No. 844 (1910)] based upon Born's definition of rigidity [Abstract No. 1723 (1909)], the following conclusion may be drawn: Uniform translations are the only motions of relatively rigid bodies which fulfil the condition of homogeneity, and thus contain all the usual characteristics of rigidity. In Herglotz's generalised motions every apparent length is maintained, but homogeneity is sacrificed.

1197. *Equations of Motion of a Particle in the Relativity Theory.* M. Abraham. (Phys. Zeitschr. 11, pp. 527-581, June 15, 1910.)—A highly analytical paper based on H. Minkowski's equations referring to four-dimensional space defined by x, y, z and $u = ict$, where i is $\sqrt{-1}$, c is the light-speed, and t is time. These equations are of the form:
$$(X, Y, Z, U) = \nu \frac{d}{ds} (x, y, z, u).$$

In these ν is density, ν is an invariant of the Lorentz transformation, i.e., a four-dimensional scalar connected with t by the relation $dr/dt = \sqrt{1-\beta}$. [See also Abstracts Nos. 1900 (1908) and 1841 (1910).]

1198. *The Second Postulate of Relativity.* R. C. Tolman. (Phys. Rev. 31, pp. 28-40, July, 1910.)—In this paper it is shown that the extraordinary conclusions of the theory of relativity are forced on it by the second postulate of relativity. This postulate is obtained by combining the first postulate of relativity with the principle that the velocity of light is independent of the velocity of the source. The alternative hypothesis that the velocity of light and the velocity of its source are additive would lead to none of the complications of the theory of relativity. Two methods are here presented for deciding between the two hypotheses. The first method would be to measure the wave-length of light from some moving source, since it is shown that the first hypothesis would lead us to expect a change in the wave-length of light from moving sources and the alternative hypothesis would not. The existing measurements of the wave-length of light from moving astronomical sources, made with reflection gratings, are not of such a nature that we can definitely decide that the velocity of light is independent of the motion of the source. We can, however, state that, if the alternative hypothesis is true, then a reflecting surface acts as a new source of light, and light coming from such a surface has the normal velocity as from any other stationary source. It is

further shown that measurements with a transmission grating would more nearly allow a definite decision of the question. The principle that the velocity of light from a stationary mirror is the same as for light from any stationary source leads to a second method of deciding between the two hypotheses as to the velocity of light. An apparatus is described in which interference fringes were produced between light which had come direct from the sun, and light which had first suffered reflection. Since the velocity of the reflected ray would in any case be unaffected by the motion of the original source, we should expect a shift in the position of the fringes to accompany a change in the velocity of the direct ray. No shift in the fringes was observed in examining light first from the approaching, and then from the receding, limb of the sun. It is therefore concluded that the velocity of light from the two limbs of the sun is the same, which confirms the principle that has led to the second postulate of relativity. An entirely different method of proving the second postulate of relativity is afforded by the results of the Kaufmann-Bücherer experiment. In fact, by a combination of the first postulate of relativity with the principle that the mass of a moving electron is greater than that of a stationary one in the ratio $1:\sqrt{1-\beta^2}$, it was found possible to deduce all the conclusions of the theory of relativity as to the units of length and time in a moving system, and finally to deduce the second postulate of relativity itself. [See Abstract No. 1998 (1908), also No. 1488 (1909).] E. H. B.

1199. *Nature of Atomic and Molecular Forces.* R. D. Kleeman. (Phil. Mag. 19, pp. 788-809, May, 1910.)—The line of investigation followed up [see Abstract No. 46 (1910)] is that of the surface tension, which is likely to throw light on the nature of intermolecular forces. A constant C_0 may be deduced from the internal heat of evaporation. It is dependent only on the nature of the atom, and is found to be proportional to the square root of the atomic weight, and also to its valency. The attraction between two molecules of the same kind is given by $\phi(x)(2C_0)^2$, where $\phi(x)$ is a function of the distance between them. The author endeavours to determine this function, and finds it to be K/x^2 approximately, a formula already put forward by Maxwell. As regards the nature of the force, it cannot be gravitational on account of its intensity. It is more likely to be electrostatic. An attempt is made to bring the law into relation with the ionising power of an α -particle and the coefficient of diffusion of gases. Finally, it is shown that the diam. of a molecule must be less than 0.1 of the distance separating liquid molecules. Considering the probable values of atomic diameters, this suggests that atoms contract in combining to form a molecule. E. E. F.

1200. *Shape of the Atom.* R. D. Kleeman. (Phil. Mag. 20, pp. 229-238, July, 1910.)—Traube has shown [see Abstract No. 2188 (1909)] that on the basis of Guldberg's calculated values of the densities of various substances at the absolute zero of temperature [see Abstract No. 1047 (1900)], the volume of an atom is proportional to the square root of the atomic mass, and that of a molecule, therefore, proportional to the sum of the square roots of the atomic masses of its component atoms. If m be the atomic mass, the cross-section of a spherical atom would therefore be proportional to $m^{1/2}$. Let Q be the sum of the diametral sections of the spheres of action of mean radius s ; N the number of molecules contained in unit volume of a gas at atmospheric pressure. Then $Q = \frac{1}{2}\pi s^2 N$, and if the atoms of the molecule all lie in a plane, the cross-section of a molecule should be approximately equal to the

sum of the cross-sections of the component atoms; in which case $Q/Em^{1/3}$ should be a constant. This ratio is determined for 65 substances of varying types, and provided mercury be assumed to be diatomic at the absolute zero, its value is found in all cases to lie between the limits 8.82 and 5.85. The variation is much less in the case of substances of similar type, each such group probably corresponding to a certain arrangement of atoms in which a definite proportion of space external to the atoms is included in Q . Considering the difficulty of experimentally determining Q , as indicated by the discrepant results of different observers, the author concludes that the figures support the usual assumption that atoms may be regarded as spherical in shape. Calculations of various coefficients of diffusion on the basis of the foregoing results agree fairly well with the observed values. According to these results the density of an atom will be greater the greater the atomic mass, as would be expected, since the contraction under the mutual attraction of the sub-atoms would increase with the atomic mass. It is also shown that Bragg and Madsen's experiments on secondary γ -radiation [see Abstract No. 469 (1909)], according to which the relative distribution of the secondary radiation round an atom approaches more nearly to constancy with increasing atomic mass, confirm the assumption of at least approximate sphericity.

1201. *Brownian Motions*. T. Svedberg. (Zeitschr. Phys. Chem., 71, 6, 571-576, Feb. 25, 1910.)—A reply to Perrin's criticism [Abstract No. 508 (1910)]. In the author's experiments, colloid platinum solutions were used, the particles being 40 to 50 μ in diam. The width of the visible field was about 85 μ . The solution was given a displacement of 200 μ per sec., so that each particle crossed the field in 3 to 4 twentieths of a second. This small interval caused the Brownian motions to appear as a wave-motion of fairly definite frequency. Hence the author's "oscillations." They can be imitated to some extent by taking any of V. Henri's cinematograms of Brownian motions and adding to them a velocity of translation in one direction. They then are drawn out into zigzags roughly resembling a wave-motion. E. E. F.

1202. *The Ether Question*. H. Witte. (Ann. d. Physik, 82, 2, pp. 382-410, May 12, 1910.)—A reply to V. Bjerknes (Ibid. 81, pp. 812-824, 1910), who answered the author's objections to the mathematical methods developed in "Die Kraftfelder" [see Abstract No. 2122 (1909)]. Bjerknes' analogy between pulsating spheres in water and electromagnetic phenomena is valuable and suggestive, but quite incapable of forming a basis for a mechanical explanation of electric phenomena. It leads no further towards such an explanation than any analogy based upon a continuous ether, which the author has shown to be inadmissible. The Bjerknes analogy belongs to the Kelvin group of mechanical systems based upon a quasi-rigid ether. The general objection to this group is that they furnish no rotation (nor, indeed, any mechanical process) unless the displacement is infinitely small. The special objection to the Bjerknes analogy relates to the reversing mechanism required to give the forces the proper sign. No such mechanism is suggested by any known physical property. It is, of course, always possible to introduce the conception of cogwheels, which, indeed, are introduced in other theories at a later stage, but are inevitably brought into action in some form or other (ether atoms) as a last resort, which clearly reveals the failure of the most obvious assumptions, but is altogether uncertain and not conducive to confidence. As a second objection, the author shows that the equations of the

field in the Bjerknæs analogy do not confer upon it the inverse force required. That they appear to do so is due to a mathematical method which the author shows at some length to be unjustifiable. Nor is it possible to introduce the missing term by other physical considerations, quite apart from the difficulty, already referred to, of reconverting the inverse force into the direct force experienced by ponderable bodies as distinct from the other. The Bjerknæs analogy is therefore, like all mechanical analogies, incomplete. Speaking generally, the author disclaims any intention of directing research into new channels. Research is already moving in those new channels, and an electro-magnetic system of mechanics has already distinct advantages over any mechanical system of electromagnetism. The renunciation of purely mechanical conceptions constitutes the progress of modern theory.

E. E. F.

1203. *Temperature and Density of the Waters of the Pacific.* G. F. McEwen. Univ. of California Publications in Zoology, 6. pp. 189-204. May 28, 1910. Contribution from the Laborat. of the Marine Biolog. Assoc. of San Diego. An account of the hydrographic work carried on by the Marine Biological Station of San Diego. Observations have been made of the temperature and density of the waters of the Pacific near the coast of Southern California. It was found that certain in-shore and shallow water regions had a temperature 2 or 3 deg. lower than the rest of the ocean, though there was no difference in the density. This is accounted for on Ekman's dynamical theory of oceanic circulation. The following table shows how the temperature decreases with increasing depth, at first rapidly and then more and more slowly; the density steadily increases with increase of depth. There were, however, several striking variations from this general rule.

Depth in Fathoms.	Temperature.	Density.
0	21.5° C.	1.02486
75	11.0	1.02512
150	10.5	1.02525
250	9.7	1.02528
850	9.2	1.02531

L. H. W.

1204. *Observations of the Upper Atmosphere made from the Russian Steamer "Neptune."* M. Rykatscheff, Jr. (Meteorolog. Zeitschr. 27. pp. 145-154, April, 1910.)—The voyage was made by the author during May and June, 1908, with the object of making observations on the open sea. A complete set of meteorological instruments and apparatus for the flying of kites, &c., was installed on the vessel, which sailed from St. Petersburg to Odessa, by way of the North Sea and the Mediterranean. Readings of the ordinary instruments was made three times daily, 7 a.m., 1 p.m., and 9 p.m., as well as hourly observations (during the day) of an Assmann psychrometer. The results of the meteorological observations are given in "Bulletin of the Imp. Acad. of Sciences," St. Petersburg, No. 10; the present paper deals with the kite observations. These latter were carried out with the assistance of W. W. Kuznetsov. Twelve ascents were made; in five cases the apparatus was sent up to a height of less than 500 m.; the others ranged from this height to 2000 m. One ascent was made in the Baltic, one in the Cattegat, one in the North Sea, three in the Bay of Biscay, and the remainder in the Mediterranean and Aegean Seas. The results of the observations show a well-

marked "inversion" in the lower strata of the air above the sea, and the author gives figures showing the variation of temperature and humidity with height. In the ascent on June 10, on the *Ægean Sea*, the inversion was very strikingly shown. The greatest height reached was about 900 m.; the inversion reached its maximum at about 290 m., but even when highest the apparatus recorded a temperature higher than that at sea-level. The comparison of observations made at Athens and those on board the *Neptune* on the same date (June 10) showed the land temperature to be about 8° higher than that at sea. Three sets of kite observations made on the same day in the Bay of Biscay furnished the data whereby a table was drawn up giving the values of the temperature, humidity, &c., at two-hour intervals, for all altitudes from 6 to 1800 m. on that date (May 31). The max. temperature for heights above 100 m. seems to be reached between 9.30 and 10.30 a.m., the minimum between noon and 1 p.m. It is only in the strata much nearer to the sea-level that the temperature reaches its maximum at a later hour of the day. The great variations in humidity at heights at from 1000 to 1600 m. shown by these observations are very interesting. In conclusion, the author gives tables of results obtained from the 12 ascents. The paper is illustrated by diagrams giving the variations of temperature and humidity with altitude, obtained from the observations. F. W. H.

1205. *Oscillations in the Mediterranean at Bonifacio.* Ferret. (Comptes Rendus, 151. pp. 112-118, July 4, 1910.)—Between 12.40 p.m. and 4.15 p.m. on April 14, 1910, the sea-level oscillated down and up at Bonifacio, the max. range being 1.55 m. and the period about 12 min. The harbour-master remembers 45 such occurrences since 1898. On the date mentioned the author noticed similar oscillations in the Bouches (du Rhône?); the max. level-change amounted to 1.2 m. between 3.30 and 4 p.m., and the wave travelled E.-W. at a rate of 4.5 knots. H. B.

1206. *Radial Velocities with Objective-prism Spectrograph.* R. W. Wood. (Astrophys. Journ. 81. pp. 460-462, June, 1910.)—After trying various absorbing media to give reference points for stellar spectra, it is concluded that the chloride of neodymium is the most suitable. Peroxide of chlorine also gives useful bands which are quite sharply defined on the red side, and their wave-length does not appear to change with variations of density of the gas. A photograph of α Leonis taken with and without the absorbing screen is reproduced in the paper. C. P. B.

1207. *Variations of Wave-length in Sunlight.* A. Perot. (Comptes Rendus, 151. pp. 38-41, July 4, 1910.)—The study of the rotation periods of the various strata in the sun's atmosphere is rendered difficult by the frequent occurrence of violent disturbances which in themselves produce changes of wave-length of the lines under examination. A special apparatus has been used to isolate a small region of the sun's surface for spectroscopic examinations by a very powerful interference spectroscope. With regard to the small difference of $0.007 \text{ \AA.U.}$ found between the wave-lengths of certain iron lines at the centre and limb by Halm, it might be explained as a relative shift towards the violet for the central area rather than a shift to the red for the marginal area. Thus the max. radial velocity at the equator will not be at the limb of the sun, but at a point within the limb such that the resultant of the rotational and ascending velocities lies in the direction of the earth.

If, however, the effect observed is due to pressure or variations in density, the difference should be localised at the extreme limb. The special cases shown indicate that this latter is the chief cause.

1208. *Genesis of Lunar Crater Formations.* P. Puleux. (Comptes Rendus, 151, pp. 183-185, July 11, 1910.)—The author examines the evidence of the large-scale pictures of the Paris Lunar Atlas for determining the mode of origin of the craters and angular crevasses on the moon's surface. The peculiar arrangement of many of the craters appears, to preclude the possibility of their being due to splash effects from an ancient meteoric bombardment, and it appears more likely that they are due to local causes. Many of the fissures, once thought to be straight, are seen on these large-scale photographs to be stepped, resembling the cracks formed in walls built up of regularly shaped blocks.

1209. *Physical Observations of Comet Halley.* F. Iniguez. (Comptes Rendus, 151, pp. 44-46, July 4, 1910.)—Photographs of the spectrum of the comet obtained on June 1, 8, 6 show a continuous spectrum with seven bright condensations. On June 1 three of the bands were observed double, and this may be due to the double nucleus which was known to exist on that day. Observations of the varying aspects of the tail before and after transit are given. **D. Eginitis. (Ibid. pp. 41-48, July 4, 1910.)**—After the transit on May 18 the nucleus of the comet presented numerous changes, becoming double on several occasions and emitting matter projected with great velocity in different directions. The length of the tail reached extraordinary dimensions, being about 145° on May 20. It seems possible that the changes of appearance of the tail were to a great extent due to the quickly varying aspect as viewed from the earth during the period when the comet was passing closest. The appearances suggest that the tail is not wholly composed of gaseous material, but of vapour intermingled with solid powder or fine dust. **E. Esclangon. (Ibid. pp. 188-190, July 18, 1910.)**—Following up the statement that the tail of Halley's comet appears curved instead of rectilinear, an attempt is made to determine the exact position of the tail on the night of May 18 by projection of the relative motion of the comet from May 17-24. It is concluded that the tail extended to a distance from the nucleus greater than that separating the nucleus from the earth, and that the mean axis of the tail was sensibly in the plane of the orbit. **D. Eginitis. (Ibid. pp. 291-293, July 25, 1910.)**—To account for the variation of the observed magnitude of the comet from that predicted it is suggested that one chief factor was the *phase* of the nucleus as seen from the earth. When nearing transit we should only see the non-illuminated portion, and practically the whole of the brightness would be due to the intrinsic luminosity of the nucleus. **H. Deslandres and J. Bosler. (Ibid. pp. 265-269, July 25, 1910.)**—Examination of the observations of the position of the tail streamers made at the Johannesburg Observatory leads to the probability of the deflection of the tail being due to its having suffered electrical repulsion by the earth. Component parts of the tail streamers were seen in the east and west parts of the sky simultaneously, so that the earth appears to have passed under the cometary arch.

1210. *Halley's Comet observed at Catania.* A. Riccò. (Accad. Lincei, Atti, 10, pp. 3-7, July 3, 1910.)—Methods of observation, work and instruments used were the same as for the great daylight comet 1910a [see Abstract

No. 662 (1910)], but from May 7 the Merz refractor was also employed, and a prismatic camera was rigged up to photograph the comet's spectrum during the period of its greatest brightness. Most of the observations were made during May. The nucleus varied in brightness with more or less regularity from mag. 3.8 (April 19) to mag. 5.1 (May 8). On May 12 it had brightened considerably, sinking again rapidly to mag. 5.0 (on 18th), and falling to 6.8 on June 2. A table is given of the diurnal variations from April 19 to June 2. Small luminous jets directed towards the sun were seen during the second week of May. The coma was regular, perhaps less distinct on the southern side. The tail was nearly always straight and narrow, not very bright. Its length varied considerably, being 7° on May 4, reaching a maximum of 110° on the 18th, and falling to 6° by June 2. Photographs were taken by Horn with three instruments, with results differing little from the eye observations, but considerable complexity appears in the envelopes surrounding the head of the comet, on the photographs taken on May 21. The spectroscopic observations, both visual and photographic, show the ordinary cometary bands of the hydrocarbon type which Fowler has recently shown to be due probably to carbon monoxide at low pressure. Measurements of the wave-lengths of the cyanogen lines were made, but owing probably to the small dispersive power of the instrument, the sodium lines could not be detected. Photographs taken during the time of transit across the sun's disc show no trace whatever that could be attributed to the presence of the comet. Seventy-four photographs of the comet, and others of its spectrum, were obtained. In all the photographs the continuous spectrum of the nucleus commences at the principal band of cyanogen ($\lambda = 888 \mu\mu$) and this forms a monochromatic image of the head of the comet, showing that the cyanogen does not extend to the region of the tail.

F. W. H.

1211. *Halley's Comet and Magnetic and Electrical Disturbances.* A. Wigand. (Deutsch. Phys. Gesell., Verh. 12. 18. pp. 511-580, July 15, 1910.)—Observations were made at Halle from May 17 to May 20 to ascertain whether magnetic or electric effects accompanied the passage of Halley's comet between the earth and the sun. On May 19 the magnetic declination fell 9' below its normal value from 2 to 4 a.m. The earth's horizontal field intensity also suffered a decided diminution during the early hours of May 19 and again from 7.30 to 11.30 a.m. Slight irregularities in the atmospheric electricity were recorded between 5 and 9 a.m. These magnetic and electrical disturbances are, in the author's opinion, probably connected with the comet.

A. D. R.

REFERENCES.

1212. *Work of the Physikalisch-Technische Reichsanstalt in the Year 1909.* (Zeitschr. Instrumentenk. 30. pp. 106-120, April; 140-160, May, and pp. 174-195, June, 1910. Electrician, 65. pp. 638-639, July 29; 784, Aug. 12, et seq. 1910.)—The usual full account is given of the work done in the course of the year. The completed researches have already been dealt with, but the original pages should be referred to for information in those cases where the work is not yet concluded.

L. H. W.

1213. *Planimetric Method of Calculating the Equation of Motion of a Damped Instrument and for Experimental Determination of the Reduced Weight and Damping Force of its Moving Parts.* A. v. Büky. (Phys. Zeitschr. 11. pp. 839-846, April 16, 1910.)—Mathematical—unsuitable for abstracting.

W. C. S. P.

1214. Strength of Punch or Riveter Frames made of Cast Iron. A. L. Jenkins. (Amer. Soc. Mech. Engin., Journ. 82. pp. 723-744, May; Discussion, pp. 1259-1289, Sept., 1910.)—The author describes experiments to determine the relation between ultimate strength of curved cast-iron specimens similar to punch and shear frames and the ultimate strength of the attached test-bars. He also compares experimental results with those determined by the various methods of analysis used in designing castings of a similar shape. C. A. M. S.

1215. Relativity Theory: Four-dimensional Vector Algebra. A. Sommerfeld. (Ann. d. Physik, 82. 4. pp. 749-776, June 21, 1910.)—Following up the space-time conceptions of Minkowski in the four-dimensional space, or Minkowski's "world," the author here begins a formal development of four-dimensional vector algebra. It is shown that in the four-dimensional space there are vectors of three kinds, and these and their scalar, vector, and tensor products are severally dealt with. The analysis is too special, however, to be briefly abstracted in detail. E. H. B.

1216. Rotational Motion of Liquids in Canals. B. Weinberg. (Phys. Zeitschr. 11. pp. 846-847, April 15, 1910.)—The author has already put forward a theorem which is connected with his theory of the motion of glaciers. In order to test this theory he has carried out a number of experiments on pitch which was allowed to flow down channels, square and triangular. The results of the experiments show that the theory also holds for liquids in canals. W. C. S. P.

1217. Physical Constants of Ice. H. T. Barnes. (Roy. Soc. Canada, Trans. 3. Sect. 3. pp. 5-27, 1909-1910.)—A summary of all the more important determinations of the physical constants of ice, including density, heat of fusion, heat of sublimation, specific heat, thermal conductivity, coefficient of expansion, plasticity, elasticity, viscosity, regelation, tensile strength, compressibility, refractive index and colour, electrical properties, and crystalline structure. W. H. S.

1218. Motion of a Pendulum Swinging through an Arc of Finite Magnitude. J. Rose-Innes. (Phil. Mag. 19. pp. 851-862, June, 1910.)

1219. Theory of Surface Forces. V. Thermodynamics of the Capillary Layer between the Homogeneous Phases of the Liquid and the Vapour. G. Bakker. (Ann. d. Physik, 82. 2. pp. 241-260, May 12, 1910. Phil. Mag. 20. pp. 135-157, July, 1910.)—Mathematical.

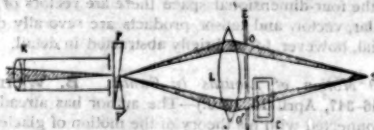
1220. Determination of Cælestat Errors. E. B. H. Wade and H. E. Hurst. (Roy. Astron. Soc., M.N. 70. pp. 512-517, April, 1910.)

1221. Anomalous Scattering of Solar Radiation. W. H. Julius. (Astrophys. Journ. 81. pp. 419-429, June, 1910.)—Not satisfied with the conclusion of the chief investigators of solar phenomena that anomalous dispersion is not a prime factor in the production of the various appearances, the author again goes over much of the ground previously noticed, and claims that his explanation equally applies [Abstracts Nos. 47 (1905) and 820 (1910)]. He now wishes to distinguish between anomalous dispersion, refraction, and scattering, and thinks that the appearances of dark flocculi and the small displacements found by Adams at the solar limb may be easily explained by one or other of these agents. C. P. B.

1222. Solar Constant. E. Bauer and M. Moulin. (Comptes Rendus, 150. pp. 1658-1659, June 20, 1910.)—It is proposed to investigate the solar constant by observing the sun with a Fery pyrometer calibrated on a black body heated to the melting-point of gold (1064° C.), and at the same time measuring the solar energy with an absolute pyrheliometer. The work should, if possible, be undertaken at a mountain observatory away from Paris. C. P. B.

LIGHT.

1223. Absorption Spectrophotometer. C. Féry. (Soc. Franç. Phys., Bull. 2, pp. 185-188, 1910.)—Two thin prisms of smoked glass P, P' (see Fig.), are placed in front of the slit of a spectroscope; these absorb and deviate the rays from two sources under comparison, or the two beams from a single source S. In the second case, one of the beams passes through an absorbing



medium C, of which the coefficient Q is to be measured. By employing the usual law of absorption, and by the aid of a plate of the same material as the prisms, the constant K of the instrument can be determined and Q found from $Q = K(x - x')/y$, where $x - x'$ is obtained from the displacement of the prisms necessary to produce equality and y is the thickness of the absorbing medium C.

1224. Pressure of Light on Gases. P. Lebedew. (Ann. d. Physik, 82, 2, pp. 411-437, May 12, 1910. Astrophys. Journ. 81, pp. 885-898, June, 1910.)—The author has succeeded in demonstrating the existence of the Maxwell-Bartoli pressure of light on absorbing gases. The pressure is proportional to the incident energy and to the coefficient of absorption of the gas for light. The actual pressures found were only about one-hundredth of the pressure which the same light would exert upon a black solid, but the measurements showed that they came within from 10 to 80 per cent. of the theoretical values. The method used consisted in enclosing a small quantity of an absorbent gas such as methane, propane, butane, ethylene, acetylene, or carbon dioxide in a small box faced with fluorspar windows and measuring the difference of pressure at the two windows produced by the passage of a beam of light filtered through a thick plate of fluorspar. To aid in the equalisation of temperature, each gas was mixed with an equal volume (or more) of hydrogen. The box communicated with a small chamber beside it, through which the pressures could be equalised. Any pressure on the gas due to the light would therefore result in a circulation of the gas through the two chambers. To measure the difference of pressure, the side chamber was nearly closed by means of a small magnalium piston, attached to a cross-piece, suspended by a quartz fibre, so as to move freely in a horizontal plane. The pressure lost by the imperfect closing of the chamber amounted to about 4 per cent., as determined by sucking a gentle stream of air past the piston. The absorption of light by gases was indicated by thermo-couples mounted at the two fluorspar windows. The greatest difficulty was presented by the necessity of concentrating the light from the Nernst lamp upon the gas chamber. This led to an irregularity of illumination which introduced an uncertainty of 80 per cent. The observed pressures ranged from 0.77 micro-dynes per cm.² for equal volumes of CO₂ and hydrogen, to 4.84 micro-dynes for a mixture of

hydrogen and normal butane. The gas chamber measured 8×4 mm. The incident energy was measured by means of a special calorimeter with a thermometer having a bulb of platinised copper. E. B. F.

1225. *Reflecting Power of Tantalum, Tungsten, and Molybdenum.* W. W. Coblentz. (Phys. Rev. 30, pp. 645-647, May, 1910.)—The reflecting power of Ta is found to increase from 10 per cent. at 1μ to 68 per cent. at 10μ , which very closely agrees with that of natural graphite. The reflectivity of the latter increases from 80 per cent. to 68 per cent. between the same limits of wave-length. The reflection spectrum of Ta therefore has the characteristic of an impure metal or an alloy. The fact that the reflectivity continues low in the infra-red tends to lower the luminous efficiency. The reflecting power of Mo and W is entirely different from that of Ta. The two former have a low reflectivity (50 per cent. and 48 per cent. respectively) in the yellow, and it rises abruptly to 85 per cent. at 2μ , beyond which it increases gradually to 96 per cent. at 10μ . Since Mo is tough and ductile it would be advantageous to use this metal for lamp filaments. E. C. C. B.

1226. *Reflection of Light at Moving Mirrors.* V. Varicak. (Phys. Zeitschr. 11, pp. 586-587, July 1, 1910.)—A non-Euclidean interpretation is given of Einstein's formulæ [see Abstract No. 2277 (1905)]. By change of variable, hyperbolic tangents are substituted for cosines in the formulæ, which then reduce to simpler forms giving rise to geometrical constructions. Thus, writing also $\tanh u$ for v/c , v being the velocity of the mirror and c that of light, Einstein's formula for the direction-cosine of the reflected ray becomes $\tanh u_1'' = (\tanh u_1' + \tanh u)/(1 + \tanh u_1' \tanh u)$, whence $u_1'' = u_1' + u = 2u - u_1$, an equation of the same form as the aberration equation in the author's previous paper [see Abstract No. 505 (1910)]. The relation $u_1'' = 2u - u_1$ can also be deduced from a formula in Hicks's investigation of the Michelson-Morley experiment. Einstein's expression for the ratio of the frequencies of the incident and reflected rays reduces to $\cosh(u_1 - 2u) : \cosh u_1$, the interpretation being that the ratio of the frequencies, or of the amplitudes, can be represented by the ratio of the arcs of two corresponding curves intercepted between common normals. The formula embodying Doppler's principle assumes a similar form to that for the frequencies. The equations lead to the deduction that the effect of the ray, before reflection, on an observer moving with velocity v' , is the same as the effect after reflection at a mirror moving with velocity v on an observer at rest. Here v, v' correspond to $u, 2u$ respectively. Bateman's results [see Abstract No. 97 (1910)] are referred to in this connection. For the case of normal incidence, the ratio of the frequency after, to the frequency before, reflection, becomes simply e^{-2u} , and can be represented by the ratio of two coaxial circular arcs.

1227. *Radiation from Metals.* E. P. Hyde. (Electrical World, 55, pp. 1654-1656, June 28, 1910. Abstract of paper read before the Amer. Physical Soc., April 22, 1910.)—This paper presents results which are a continuation of work dealt with in a previous paper [Abstract No. 802B (1909)] in which two new photometric methods of studying the radiation of metals were described and used. These methods are based on the assumption that if the ratio of the energy at a certain point in the red, to the energy at a certain point in the blue end of the spectrum is the same in the case of

two incandescent filaments, and if in addition the lumens per watt are the same in each case, then the partition of energy throughout the complete spectrum is the same. But if the lumens per watt differ, then the one filament in general radiates selectively with respect to the other. By means of methods based on the above assumption, the author previously gave numerical data regarding the relative selectivity of carbon, Ta, W, and Os. He has since studied the behaviour of Pt which he places intermediate between the true black body and the metals referred to above. This is interesting because it had hitherto been supposed that Pt deviated furthest from the black-body radiation. The author next proceeds to discuss in some detail the Wien relation, $j = C\lambda^{-5} e^{-\frac{a}{\lambda T}}$, and draws the conclusion that this equation does not apply rigidly to such metals as those referred to above, probably because "a" varies for different values of λ . Further investigations will be made to determine if the generalised Planck relation applies more exactly. For this to be the case, "a" must be constant over a wide range of temperature.

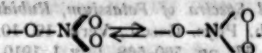
1228. *Polarisation Phenomena in Liquid Crystals of Cholesterol Ester.* F. Giesel. (Phys. Zeitschr. 11, pp. 192-198, March 1, 1910.)—Both the light reflected from, and that transmitted by, an iridescent super-cooled mixture of cholesterol esters is circularly polarised, but in opposite directions.

1229. *The Absorption of Sodium Vapour.* G. B. Clinkscales. (Phys. Rev. 30, pp. 594-609, May, 1910.)—A study of the absorption spectrum of Na vapour with both a 14-ft. and a 25-ft. grating, the object being, firstly, a measurement of the absorption lines, and secondly, their behaviour on a variation of the pressure. There appear about 10,000 lines arranged in bands between the limits $\lambda = 6700$ and $\lambda = 4500$. The pressure was varied by the admission of pure hydrogen. The bands may be divided into two classes: First, those in which the extent of fluting varies directly as the pressure is increased from 1 mm. to 760 mm.; and second, those which are not affected much by pressure. With increase of pressure up to 8 atmos. the absorption becomes continuous. As the pressure is raised from 1 to 760 mm., many of the lines between $\lambda = 4600$ and $\lambda = 5100$ shift their position by 0.15 Å.U.; no such effect is visible in the red. In one set of experiments nitrogen was substituted for hydrogen, but the effects were identical.

1230. *Absorption Spectra of certain Salts in Aqueous and Non-aqueous Solvents.* F. L. Cooper. (Astrophys. Journ. 31, pp. 889-908, May, 1910.)—The absorption of a number of Co salts has been observed in various solvents; especially water and alcohol. To these have been added the results of observations of some salts of Cu, Nd, and of FeCl₃. The absorption is due to different kinds of absorbers, one of these at least being the molecule and another the atom. The solvent has a considerable influence owing to the formation of simple addition compounds. Each constituent of the molecule plays some part in the absorption produced.

1231. *Absorption Spectra of the Nitrates.* K. Schaefer. (Zeitschr. wiss. Phot. 8, pp. 212-234, April, and pp. 267-287, May, 1910.)—An exhaustive study of the absorption of alkyl and metallic nitrates. In no case could any selective absorption be found with the alkyl nitrates either in solution

or in a state of vapour. In every metallic nitrate examined the characteristic ultra-violet absorption band was detected. Beer's law was found to hold good in many cases, but not in all. The absorption band appears to be independent of the amount of ionisation, for in the case of KNO_3 the absorption is the same for the solid substance and for strong and weak aqueous solutions. In the case of $\text{Cu}(\text{NO}_3)_2$ the nitrate absorption band was not visible in strong solution (N/1 and over) owing to the overlapping of the general absorption of the Cu ion. The author suggests that the absorption is due to the oscillation expressed by—



He does not confirm Hartley's conclusions as to the influence of the mass of the kation upon the position of the absorption band, and, moreover, attributes the band not to the degree of dissociation, but to the ease with which the ions are formed. E. C. C. B.

1232. *Relative Duration of the Rays of Calcium in the Spark with Self-induction.* G. A. Hemsalech. (Comptes Rendus, 151, pp. 220-223, July 18, 1910.)—The author has measured by his method the relative duration of the rays of Ca with two different condenser capacities, and compared the two values in each case. The arc and spark lines differ to a certain extent. An interesting feature is that in some cases it would be possible by this method to differentiate between the lines of an element and those of an impurity. E. C. C. B.

1233. *Conditions under which the Cyanogen Bands appear.* A. de Gramont and M. Drecq. (Comptes Rendus, 150, pp. 1235-1238, May 17, 1910.)—The authors note that the cyanogen bands appear extremely frequently in light sources. For example, they appear strongly in the spark-spectrum of Na_2CO_3 (free from NaCNO). It seems unnecessary to presuppose the existence of cyanogen, but only to have the simultaneous presence of C and N. The band at $\lambda = 8888$, being the brightest, forms a very delicate test for the presence of C, for 0.5 per cent. of Na_2CO_3 can be thus detected in the presence of NaCl . E. C. C. B.

1234. *Positive Band-spectrum of Nitrogen and its Change with Temperature.* E. Angerer. (Ann. d. Physik, 82, 3, pp. 549-576, June 2, 1910.)—An exhaustive study of the positive band spectrum of nitrogen and the changes it undergoes with decrease in temperature. Various forms of vacuum tubes were employed both with and without electrodes, and very great care was taken with the preparation of the gas in a state of purity. Details are given of the changes which occur, and also the wave-lengths of the lines. E. C. C. B.

1235. *Spectra of Erbium Compounds and the Valency Hypothesis of J. Stark.* K. A. Hofmann and H. Kirmreuther. (Zeitschr. Phys. Chem. 71, 3, pp. 812-824, Feb. 4, 1910.)—The authors have examined the absorption spectrum of certain salts of Er, using the reflection method so that the substances could be dealt with in the solid state. The spectrum then consists of very narrow absorption bands, if care be taken that the salts are absolutely anhydrous. There is a very marked similarity between the spectra of all the

substances even if they be so widely different in the chemical sense as ErCl_3 and Er_2S_3 . For this reason the bands must be due to the locked electrons (Stark), since it is impossible that the saturated valency electrons could be so similar in their vibrations in all the Er salts. A further proof of this is brought forward in the different spectra produced in solution, when, owing to the secondary valencies being brought into play, hydrates and solvates are formed. Especially is this the case with the acetylacetone compound of Er.

E. C. C. B.

1236. *Fundamental Spectra of Polassium, Rubidium, and Cesium.* E. Goldstein. (Deutsch. Phys. Gesell., Verh. 12. 10. pp. 426-443, May 30, 1910. Phys. Zeitschr. 11. pp. 560-568, July 1, 1910.)—In a previous paper it was shown [see Abstract No. 232 (1909)] that if the discharge from an induction coil is passed through a highly exhausted vacuum tube containing some well-powdered metallic salt, the spectrum of the metal is well seen; if a condenser be used in parallel with the tube the spectrum of the anion (Cl, Br, I) becomes visible. If, however, KF be used, a new spectrum of K is obtained with the condensed discharge, the lines of F being too weak to interfere. Similar spectra are also obtained with Rb and Cs. The author calls these the fundamental spectra, and describes in the paper how they may be obtained. The most satisfactory method is to use the vapours of the metals themselves.

E. C. C. B.

1237. *Canal-Ray Spectra.* B. Strasser. (Ann. d. Physik, 82. 5. pp. 1107-1110, July 8, 1910.)—Researches on the Doppler-effect in canal rays have shown the presence of stationary lines in the spectrum, as well as displaced lines. The stationary lines, according to J. Stark, are caused by the moving canal-ray particles colliding with the stationary gas molecules, the latter undergoing deformation owing to the shock, thereby receiving internal oscillatory energy. The emission of light takes place during, or immediately after, the collision. The object of the present research is to show that the moving canal-ray particles are able, by collision with stationary gas molecules, to cause the spectrum of the latter to be emitted. The canal rays are generated in hydrogen gas, and then caused to enter a space filled with another gas. The tube used for this purpose consists of two wide parts connected by a narrow tube 6 cm. long and 2 mm. internal diam. The wide part in which the canal rays are formed is filled with hydrogen gas, and the other wide part is filled with air at the same pressure. A diagram showing the detailed structure of the tube is given. Comparisons of the intensity of the hydrogen and violet nitrogen lines are made by means of a pocket spectroscope, and also photographically. In the latter case a Hartmann microphotometer is used to compare the blackening due to the hydrogen line H_β with that due to a violet nitrogen line in four positions, and a diagram is constructed in which the ordinates represent the degree of blackening in arbitrary units, and the abscissæ show the length of the canal-ray bundle, i.e., the distance from the kathode. From this diagram it appears that the nitrogen lines are present almost immediately behind the kathode. The intensity of these lines increases in the course of the canal rays, reaches a maximum, and then slowly decreases. On the other hand, the hydrogen lines show a steady decrease in intensity as the distance from the kathode increases. These experiments seem to prove the truth of the above hypothesis due to Stark.

A. E. G.

1238. *Absolute Wave-lengths of H and K Calcium Lines.* C. E. St. John. (Astrophys. Journ. 81. pp. 142-156, March, 1910. Contribution from the Mt. Wilson Solar Observatory, No. 44.)—The wave-lengths of the violet H and K lines of calcium have been determined with reference to secondary standards based on the red cadmium line adopted as the primary standard by the International Union for Co-operation in Solar Research at Meudon in 1907. Several spectrographs have been used in the investigation, the largest being a 30-ft spectrograph having a plane grating of 14,498 lines to the inch; third order scale of which is 1 mm. = 0.60 Å.U. The final values adopted are $\lambda H = 8988.476$, and $\lambda K = 8988.667$. [See Abstracts Nos. 677 (1906), 1559 (1909).] C. P. B.

1239. *Absorption Spectrum of Sulphur Dioxide.* F. Lowater. (Astrophys. Journ. 81. pp. 811-838, May, 1910.)—Previous work by the same author [Abstract No. 1877 (1906)] had suggested that the absorption spectrum of sulphur dioxide was subjected to well-defined changes under variations of quantity and pressure. The present investigation was undertaken to determine if the absorption bands could by any means be broken up into lines. With a column of gas 20 cm. long it was found possible to do this, but they were not well defined. Working under various other conditions it was found that a length of 60 cm. gave the best-defined lines. Pressures of 0.8 mm. to 1 atmo. were employed. The spectrum was found to consist of about 590 lines between $\lambda 2707$ and $\lambda 8120$. Wave-lengths for these are given, and also a classification into 44 series. From these it is evident that the spectrum exhibits a simple and definite structure, built up of a number of series of lines characterised by equidistant frequencies, this equal distance being 223.

C. P. B.

1240. *Anomalous Zeeman-effect.* O. M. Corbino. (Accad. Lincei, Atti, 19. pp. 687-690, May 22, 1910.)—The author criticises a previous work of M. Tenani [see Abstract No. 1589 (1909)] on the grounds of the uncertainty of the distribution of the discharge used as source of light, owing to the magnetic field. M. Tenani. (Ibid. pp. 544-548, May 1, 1910.)—Tenani replies to the objections raised by Corbino, and describes a method of studying the effect by producing an image of the discharge by means of a lens and grating, the result of which is to confirm his previous observation. Further, a method of using a vessel of Bravais' iron solution for studying the magnetic field due to an electromagnet is described. [See Abstracts Nos. 55 (1908) and 912 (1910).] S. G. S.

1241. *Longitudinal and Transverse Zeeman-effect in the D Lines of Sodium and the Green Line of Mercury.* H. Nagaoka. (Mathematico-Physical Soc., Tôkyô, Proc. 5. 16. pp. 272-278, May, 1910.)—A determination of the value of efm from the magnetic resolution of the D lines and the Hg green line, great care having been taken in the determination of the magnetic field. The results obtained are in close agreement with other determinations even though the lines observed show complicated separation. E. C. C. B.

1242. *Difference in the Change of Frequency between Longitudinal and Transverse Zeeman-effects.* H. Nagaoka and T. Takamine. (Mathematico-Physical Soc., Tôkyô, Proc. 5. 16. pp. 278-284, May, 1910.)—In a previous paper it has been shown that the transverse Zeeman-effect is not proportional to the field [see Abstract No. 247 (1910)], and in the present paper an accurate comparison between the longitudinal and transverse effects in weak and

strong fields is described, and the want of proportionality in the latter is fully confirmed. Great care was taken in the measurements, and the possible source of error due to the broadening of the lines was recognised and guarded against as far as possible.

1243. *New Type of Nonet.* H. Nagaoka. (Mathematico-Physical Soc., Tokyo, Proc. 5, 16, pp. 284-287, May, 1910.)—A new type of nonet is given by the magnetic resolution of the line $\text{Hg } \lambda = 5789$. In Runge's nomenclature the structure is given by $0, \pm a/8, \pm 3a/8, \pm 5a/8, \pm 7a/8, \pm 9a/8$, where a is the normal triplet interval. Four types of nonets are now known.

A. $0, \pm a$
B. $0, \pm a/8, \pm 3a/8, \pm 5a/8, \pm 7a/8, \pm 9a/8$
C. $0, \pm a/4, \pm 3a/4, \pm 5a/4, \pm 7a/4$
D. $0, \pm a/2, \pm 3a/2, \pm 5a/2, \pm 7a/2$

B is given by $\text{Hg } \lambda = 5789$, C by $\text{Ne } \lambda = 6878$ and 6805 , and D by $\text{Hg } \lambda = 5461$. Probably there is another type $0, \pm a/16, \pm 3a/16, \pm 5a/16, \pm 7a/16, \pm 9a/16$, and possibly $\text{Cu } \lambda = 5105$ belongs to this type, but this is not certain. Probably triplets which show broadening of the lines, maintain symmetry in high fields, and give values of e/m greater than 1.87×10^9 , belong to some intermediate types.

E. C. C. B.

1244. *Zeeman-effect and Pressure Displacement.* A. S. King. (Astrophys. Journ. 81, pp. 438-458, June, 1910.)—The author reviews very systematically the evidence at present available concerning the connection between the Zeeman-effect and pressure displacement of spectral lines, and gives quantitative details of measurements made at the Pasadena Laboratory for the metals Fe, Cr, and Ti. The theories put forward by Humphreys [Abstracts Nos. 1054 (1906), 1814 (1907), 1086 (1908)], Richardson, and Larmor are concisely described, and the author then proceeds to describe his experimental investigation for obtaining data by means of which the theories may be tested. Tables are given showing the details of Zeeman-effect as determined from the Pasadena plates compared with the pressure displacements given by Humphreys and Duffield. The discussion of these shows that taking the ratio of magnetic separation to pressure displacement there is a very great range of this factor, from 0.78 to 15.5. By classifying the values as small, medium, and large, it is then attempted to see if any further connections may be obtained by taking only the greater effects into consideration. From this we see that in the case of iron 44 per cent. of the lines considered are in good agreement as to the magnitude of the two phenomena, 42 per cent. show a probable discordance, while 14 per cent. strongly contradict the hypotheses of equality of relative magnitude. The chief point of agreement appears to be that the magnetic phenomena and pressure displacements show a tendency to increase with wave-length, and more data are required of the pressure phenomena to compare more closely with the great amount of Zeeman material that is available.

C. P. B.

1245. *A Method for the Observation and Study of the Zeeman-effect.* J. Guadet. (Annal. Chim. Phys. 20, pp. 288-298, June, 1910.)—A device by which the magnetic resolution of spectrum lines viewed parallel to the lines of force in very weak fields can be detected and measured. In the usual arrangement a quarter-wave plate is introduced into the line of vision

so that the rays from the two components are plane-polarised at right angles to each other. It is suggested that in place of the one simple quarter-wave plate two should be used, set edge to edge with their axes at right angles to one another, and so arranged that the junction of the two plates horizontally bisects the beam of light. If now a Nicol prism be set up behind the quarter-wave plates, the field will be seen to be divided into two halves, of which the upper one is illuminated only by one component, and the lower one only by the other component. By the use of an interferometer or Fabry and Perot étalon, it is possible to measure the separation of the two components. With a 2-cm. étalon it is possible to observe the magnetic resolution in a field of 200 gauss. The author points out that the apparatus can be used for the detection of the Zeeman-effect if present in the light from the stars.

1246. *Studies in Thermo-luminescence. III. Distribution of Energy in the Luminescence Spectrum of Sidot Blende.* C. A. Pierce. (Phys. Rev. 80, pp. 668-678, June, 1910.)—The method employed consisted in photographing on the same plate one spectrum of the fluorescence light and four spectra of the light of an acetylene flame. Different intensities of acetylene were used for the four spectra, while the time of exposure for the five spectra was the same. The distribution of intensity was determined by a photometric measurement of the transmitted light through the photographs with a Lummer-Brodhun photometer. Full curves are given in the paper, and they show that the fluorescence of Sidot blende exhibits a band from $\lambda = 0.46 \mu$ to $\lambda = 0.80 \mu$ with a maximum at $\lambda = 0.55 \mu$. There may be another band in the longer wave-lengths. The energy distribution in the fluorescence light and the phosphorescence light immediately after excitation is the same.

1247. *Radiation from Potassium.* E. Henriot. (Comptes Rendus, 160, pp. 1750-1751, June 27, 1910. Le Radium, 7, pp. 160-171, June, 1910.)—The paper is a continuation of a previous investigation on the same subject [see Abstract No. 669 (1910)], and deals with experiments to show that the activity of potassium is atomic. The author has examined the radiation from various potassium salts, and finds it proportional to the amount of potassium contained in the salt, and also that the rays given off by various salts are absorbed by tin-foils to the same extent. [See also Abstract No. 917 (1910).] Experiments carried out between 14° and 140° C. showed that temperature had no effect on the radiations.

1248. *Scattering of α -Particles by Matter.* H. Geiger. (Roy. Soc. Proc. Ser. A, 88, pp. 492-504, April 14, 1910.)—In a previous paper [Abstract No. 1029 (1908)] the author has described experiments which gave direct evidence of the scattering of the α -particles. In the present investigation this scattering has been studied quantitatively and in more detail. In the experimental arrangement the α -particles from a strong source of RaC (deposited *in situ* by manipulation of RaEm) pass along an evacuated tube through a small hole in a metal plate, and eventually strike a zinc sulphide screen where they produce a small area of scintillations. On placing thin metal-foils in the path of the α -particles the distribution of the scintillations on the screen is altered, and from the observations of the new distribution the most probable angle of scattering is deduced, it being found that the curve of scattering is similar to Maxwell's distribution curve of the velocity

of gas molecules. This most probable angle of scattering increases for small thicknesses approximately proportionally to the square root of the thickness of the scattering foil, but for greater thicknesses it increases more rapidly. With different materials the probable angle through which an α -particle is turned in passing through an atom is proportional to its atomic weight, the actual value in the case of gold being about $1/200$ of a degree. The author has also investigated the variation in the probable angle of scattering of the same foil when the velocity of the incident α -particles is changed, and finds that, to a first approximation, the variation is inversely according to the third power of the velocity. Thus the scattering increases very rapidly towards the end of the range, suggesting that scattering plays an important part in the apparent sudden stoppage of α -particles when they have still considerable velocity. E. M.

1249. *Transmission of β -Rays through Matter.* H. W. Schmidt. (Phys. Zeitschr. 11, pp. 262-278, April 1, 1910.)—A continuation of the work described in a former paper [See Abstract No. 251 (1910)]. The question of transmission of β -rays through compounds is dealt with, and in this connection the following equations are established: $\mu/D = (\beta/D) \sqrt{u^2 - 1}$, and $\phi = u - \sqrt{u^2 - 1}$. In the latter equation—

$$u = 1 + a/\beta = 1 + \frac{C_1}{C_2} \cdot \frac{(a\sqrt{A_1^2} + b\sqrt{A_2^2} + c\sqrt{A_3^2} + \dots)}{(xA_1^2 + bA_2^2 + cA_3^2 + \dots)},$$

A_1, A_2, A_3 being the atomic weights of the elements forming the compound X, Y, Z , and C_1 and C_2 the constants for the rays used, a represents the absorption coefficient, and β the reflection coefficient, D the density of the substance, and ϕ the max. reflected radiation energy. Thus a/β depends upon the chemical constitution of the material on which the rays fall, and in the complete formula for calculating ϕ in the case of compounds, only the constants C_1 and C_2 , the atomic weight of the elements, and the number of atoms forming the molecule, occur. An apparatus is described by means of which the transmitting power of liquids for β -rays can be investigated, and it is shown that the experimentally obtained magnitudes are in complete accord with the values obtained by calculation using the above formula. The above rule for compounds is also made use of to explain the results obtained by S. J. Allen with respect to the reflected and transmitted β -radiation. The result of this work can therefore be looked upon as an argument in favour of the conclusion that, in the case of the transmission of β -rays through matter, all differences peculiar to the material vanish. Further researches on different kinds of matter are, however, necessary before the general law can be considered established. (Phys. Zeitschr. 11, pp. 262-278, April 1, 1910.)

1250. *Ionisation produced by α -Particles.* II. H. Geiger. (Roy. Soc., Proc. Ser. A, 83, pp. 505-515, April 14, 1910.)—The experiments described were undertaken to throw light on the law of absorption of the α -particle, and to establish, if possible, a connection between its velocity and ionising power. Rutherford [Abstract No. 1712 (1906)] measured the relative velocity at different points of the path photographically, but the comparatively high values obtained by him for the velocity at nearly the max. range rendered a redetermination of the velocity of an α -particle along its path desirable. A scintillation method was employed to measure the deflection of the particles in a magnetic field, and the velocities deduced from the obser-

variations are practically identical with Rutherford's values, except for the end of the range, the values at 7 cm. range being 0.48 (Rutherford) and < 0.2 (Geiger). The average values of the velocity deduced from a number of observations, plotted against the distance x agree well with the equation $v^2 = a(R-x) \dots (1)$. The best agreement is obtained by taking R equal to 7, and since the velocity of the α -particle is assumed to be unity for $x=0$, the factor a becomes 0.148. It seems probable that the difference at the end of the range between the author's and Rutherford's results is due to the use of Al sheets in Rutherford's experiments. These sheets are never quite uniform in thickness, and so a certain fraction of the α -particles will, after passing through them, still have velocities above the average. But these swifter particles are most effective photographically, and so the deflection will in consequence appear too small. The author used sheets of mica. As regards the scattering of α -particles in passing through gas, it was found that towards the end of the path the velocity is not the same for all particles, some of them being able to travel several mm. further than others. A similar result was obtained by using polonium as a source of rays. The latter part of the paper deals with the relation between the velocity and ionising power of α -particles. Assuming that the ionisation produced by an α -particle in a given thickness of matter is proportional to the energy absorbed, it follows that the ionisation I is given by $I = a/(R-x) \dots (2)$, where R and x have the same meanings as in equation (1). Combining equations (1) and (2) we have $I \propto v = \text{constant}$, i.e., the ionisation or expenditure of energy is inversely proportional to the velocity. Both equations (1) and (2) are in agreement with experimental data. Bragg, starting from different equations, arrived at the same conclusions regarding the ionisation and velocity [Abstract No. 889 (1907)].

1251. Ionisation and Absorption by β -Rays of Actinium. R. D. Kleeman.

(Roy. Soc., Proc. Ser. A. 88. pp. 580-583, April 14, 1910.)—It is known that the β -rays of Ac differ from those of Ur in being more easily absorbed by matter. In the present investigation a comparison has been made of the relative ionisations which the two types of β -rays produce in different gases. The ionisations were in each case referred to that produced in air as unity, and the author finds that these relative ionisations are the same. The author also points out that although the coefficients of the absorption of the two types of β -rays by different metals differ considerably, yet relatively they are the same up to that of tin inclusive; the atomic weight of tin being near to that of iodine, the heaviest atom occurring in the gases used in the above experiments. This does not hold, however, when the coefficients of absorption of lead are included. The author also discusses the bearing of the foregoing results on the nature of the ionisation in a gas by γ -rays.

E. M.

1252. Question of Homogeneity of γ -Rays. F. Soddy, W. M. Soddy, and A. S. Russell. (Phil. Mag. 19. pp. 725-757, May, 1910.)—The question as to the homogeneity of the γ -rays is a somewhat unsettled one, and is becoming more interesting in view of the question as to the homogeneity of the β -rays. In the case of the γ -rays from Ra, most observers have given results showing that the coefficient of absorption by lead decreases with increased thickness of the lead [see Abstract No. 2562 (1904)]. The present investigation deals with a careful investigation of this variation of the absorption coefficient, and the influence on it of secondary disturbing factors.

In the experiments described the ionisation vessel takes the form of two hemispheres with the radium at the centre, and the absorption plates are in the form of truncated hemispheres, this disposition being one for which the theoretical expressions can be easily evaluated. With this arrangement the authors find that the γ -rays of Ra are absorbed by lead as a homogeneous non-scattered radiation with a constant value of the absorption coefficient $\lambda (=0.50)$ over the whole range up to 7.7 cm. Further experiments showed that with suitable precautions as to secondary disturbing radiations this coefficient holds up to 22 cm.; the variation at great thicknesses found by previous observers being due to the formation of peculiar secondary radiations. As the β -rays from Ra are not homogeneous, these experiments lend support to the view that the β - and γ -rays are not interdependent. The value of the absorption coefficient for γ -rays, over the higher ranges of thickness for which absorption is always strictly exponential, can be varied within fairly wide limits, being, for example, always diminished when the rays first traverse a denser substance ("hardening"). The abnormal ratio $\lambda \text{Urx/Ra}$ for lead (1.465) obtained in previous experiments is so accounted for, in general the ratio $\lambda \text{Urx/Ra}$ being about 1.25.

1263. Radium D and its Products of Transformation. G. N. Antonoff. (Phil. Mag. 19, pp. 825-846, June, 1910.)—The present investigation deals mainly with the question as to whether or not RaE is complex and consists of a rayless product RaE₁ and a β -ray product RaE₂. In the experiments described a β -ray product was separated from RaD and found to decay according to an exponential law with a period of 5 days, while the RaD, inactive immediately after the separation, recovered its β -ray activity according to the same period. The product was separated by its being less volatile at high temperatures than RaD, and it was also found that along with RaF₁ (polonium) it could be completely separated from Ra and RaD by precipitation with barium sulphate in an acid solution of radium. As a result of the various experiments, the author concludes that RaE has a period of 5.0 days and follows directly after RaD without any intermediate product, and that the β -rays which it emits are absorbed according to an exponential law with a coefficient for aluminium of 48 cm.⁻¹. The author has also determined the period of RaD by measuring the amount of RaF₁ produced in a given time from a known initial amount of RaEm. The RaF was measured by a scintillation method, and the mean half-value period of RaD calculated from the measurements was 16.5 years.

1264. Recoil of Radium B from Radium A. W. Makower and S. Russ. (Nature, 83, p. 460, June 16, 1910.)—When RaA is transformed into RaB the process is accompanied by the expulsion of an α -particle. It has been shown that in these circumstances the atom of RaB recoils from the α -particle with considerable velocity. Taken together, the results of the electrostatic and magnetic deflections of the atoms of RaB after recoil, leave little doubt that the atomic weight of RaB is in the neighbourhood of 200; that this product carries with it on recoil a single positive atomic charge; and that the velocity of the particles is of the order of magnitude to be expected from considerations of momentum. It is, however, hoped that subsequent experiments may lead to a determination of these important quantities with accuracy.

1265. β -Ray Activity of Uraninite. S. J. Lloyd. (Journ. Phys. Chem. 14, pp. 509-527, June, 1910.)—The percentage of the total β -ray activity of

uraninite contributed by each constituent of that mineral has been investigated by Boltwood [see Abstract No. 1100 (1909)], and the present paper deals with experiments to ascertain the percentage β -ray activity of the constituents. The β -ray constituents UrX, RaB, RaC, and RaE, were obtained in thin films, and their β -ray activities compared with that of a standard uranium oxide film. In the case of uraninite itself a correction had to be made for the amount of RaEm spontaneously given off. The UrX was investigated by growing it from uranium nitrate instead of uraninite, and the author gives details of its chemical properties. RaB and RaC were investigated by estimation of the RaEm evolved, while their individual activities were compared by volatilising the RaB. The estimation of RaE was effected by first separating out the RaD by chemical methods. With the electroscope used the results were: UrX, 82.1 per cent.; RaB, 16.1; RaC, 36.1; RaE, 10.9 per cent., leaving a residual 4.8 per cent. which may possibly be due to experimental error. The author has also investigated the radio-uranium indicated by Danne's experiments [see Abstract No. 478 (1909)], but was unable to obtain any evidence of its existence. E. M.

1256. *Decay of Polonium.* J. W. Waters. (Phil. Mag. 19, pp. 905-906, June, 1910.)—The nature of the product of disintegration of polonium is a matter of considerable interest. If the product is a solid substance, it will accumulate in the course of time, and if it is radio-active its presence will be shown by the deviation of the curve of decay of radio-activity of the polonium from an exponential curve. During the past few months the author has determined the rate of decay of a specimen of polonium which was about 5 years old; its activity being therefore about 1/1000 of the initial activity. The rate of decay was found to be normal, being nearly the same as that found by Mme. Curie for the initial rate. E. M.

1257. *Decay Constant of Uranium X.* F. Soddy and A. S. Russell. (Phil. Mag. 19, pp. 847-851, June, 1910.)—Using intensely active preparations of UrX, separated from 45 kg. of uranyl nitrate, the authors have made a careful examination of the decay of both β - and γ -rays, over periods of time up to 280 days in the case of the latter, and for considerably longer in the case of the former. The investigation shows that the β - and γ -rays decay at exactly the same rate, the value of the constant λ being 0.0282 (day)⁻¹. The period of average life of the body is therefore 85.5 days, and its period of half-change 24.6 days. Both the β - and γ -ray activities were found to decay to zero, while the uranyl nitrate recovered its equilibrium content of UrX quite normally, there being no evidence of a product intermediate between Ur and UrX. E. M.

1258. *Thorium D.* F. v. Lérch and E. v. Warburg. (Akad. Wiss. Wien, Sitz. Ber. 118. 2a, pp. 1675-1590, Dec., 1909.)—By means of the electrolysis of acid solutions of the active deposit from Th emanation, ThB can be obtained on a Pt kathode. If the current is only allowed to pass for a short time, the β -ray activity of the kathode first increases to a maximum and afterwards decays with a period corresponding to that of ThB. The authors explain these results by assuming that ThB gives rise to a β -ray product of short period (8.1 min.) identical with the ThD first discovered by Hahn and Meitner by the recoil method [Abstract No. 640 (1909)]. Thorium B is also deposited on metallic Ni placed in the active deposit solution, while the β -ray activity curve shows by short exposure a similar rise and decay to that in the

case of electrolysis, indicating that in both cases ThD is deposited in smaller quantity than ThB. The authors describe experiments showing that ThD is more volatile than ThA and ThB, and that it is also less soluble in strong acids. E. M.

1259. *Helium in the Atmosphere.* A. Piutti. (Le Radium, 7, pp. 142-146, May, 1910. From the Italian.)—The paper deals with a sensitive method of estimating the amount of helium in the atmosphere and also in minerals. The principle of the method depends upon the absorption of the other gases than He by cocoanut charcoal immersed in liquid air, the He being estimated by the intensity of the various He lines in a spectroscope placed along the prolongation of a Plucker tube. The author has succeeded in detecting the presence of He in 8.5 cm.³ of the air at Naples, corresponding to an amount of He of the order $\frac{1}{2}$ mm.³. The author also gives details of measurements of the He given off when different zircons are heated; these measurements, being compared with their radio-activity and density. Of the nineteen specimens examined the zircon from Vesuvius contained the smallest amount of He relative to its radio-activity, and that from Renfrew (Canada) the highest. E. M.

1260. *Non-radioactive Minerals containing Helium.* A. Piutti. (Le Radium, 7, pp. 146-149, May, 1910. From the Italian.)—The experiments described are in continuation of those in the preceding Abstract. A table is given relating to the He evolved by the heating of twenty-five specimens whose activity was less than $\frac{1}{10000}$ that of uranium oxide, the specimens being chiefly different varieties of tourmaline. Another table is given relating to specimens whose activity exceeded the above amount. The crystals of a specimen of tourmaline from Madagascar exhibited a peculiarity in that the radio-activity and He-content of the outer layers were greater than those of the interior. E. M.

1261. *Radio-active Emanations existing in the Air of Naples.* L. d'Aquino. (Elettricista, Rome, 9, pp. 177-178, June 15, 1910.)—Measurements of the rate of decay of radio-activity of a brass wire, 11 m. long, and 0.8 mm. thick, which was exposed for intervals of several hours to the air of Naples, at a negative potential of 220 volts, show the presence of disintegration products of thorium emanation, the activity due to Th being 80 per cent. of the total activity of the air. W. H. Si.

1262. *Radio-activity of Dew.* C. Negro. (Phys. Zeitschr. 11, pp. 189-191, March 1, 1910. From the Italian.)—Glass plates were placed at night on the soil, and in the morning were weighed and tested for radio-activity by means of an Elster and Geitel apparatus. After about an hour no activity is observable, but if the weighing of the plates is dispensed with the ionisation of the air is more intense and persists longer. In all cases higher values are obtained with a negative than with a positive charge. The radio-activity diminishes to one-half its value in little more than half an hour, and then seems to decrease rather more slowly. It seems probable that the radio-activity originates in the soil. T. H. P.

1263. *Radio-activity of Hot Springs.* D. Iitani and K. Manabe. (Mathematico-Physical Soc., Tōkyō, Proc. 5, 15, pp. 228-240, April, 1910.)—In these experiments the method of bubbling is used in conjunction with the

fontactoscope of Engler and Sieveling. The mathematical theory relative to the amount of emanation present in the observation chamber during bubbling is dealt with at some length, and then the effects of variations in the pressure and temperature, as well as errors brought about by neglecting to take account of diffusion, are considered. It is concluded that the effects due to changes of pressure are not great, but the period of the emanation as obtained by this method may be reduced by 80 per cent. by variations in the temperature. The estimation of the effect due to convection of the emanation when the temperature inside the chamber is higher than the outside is not attempted. The calculation given shows that the effect of diffusion on the observed decay-constant of the emanation may under certain circumstances be very large. It is found that if a few hours after the introduction of the emanation into the chamber are excluded, the decay of activity is exponential, and has a period of about 14 hours. In the case of the hot water and gas from the Yugawara Spring it is found that RaEm is present, and probably also ThEm in a small proportion. The hot water from the spring at Izusan contains radio-active gas, which is mainly RaEm, and the same is found to be the case with the hot springs at Atami. The hot water from the geyser at Atami does not contain emanation in any measurable quantity, while the steam ejected from the orifice contains RaEm. This is explained on the assumption that the water is in a state of ebullition before it is ejected from the orifice. By ebullition the water gives off the emanation contained in it, and this remains in the cavity mixed with the vapour.

A. E. G.

REFERENCES.

1264. *Registration Micrometer for Spectra.* O. Lohse. (Zeitschr. Instrumentenk. 30. pp. 169-173, June, 1910.)—Description of a new measuring micrometer for spectra, with a series of registration keys for recording the readings directly as observed.

C. P. B.

1265. *Diffuse Reflection with Extended Sources of Light.* C. Hillebrand. (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 1399-1416, Nov., 1909.)—A highly analytical discussion of the problem.

E. H. B.

1266. *Scattered Light in Spectrophotometry and a New Form of Spectrophotometer.* H. E. Ives. (Phys. Rev. 30. pp. 446-459, April, 1910.)—Scattered light when unsymmetrically distributed over the field of vision detracts very considerably from the accuracy of spectrophotometric work. A simple instrument is described in which the unsymmetrical distribution of scattered light is reduced to a minimum.

E. C. C. B.

1267. *Electron Frequency from Dispersion.* C. Schaefer. (Ann. d. Physik, 32. 4. pp. 883-888, June 21, 1910.)—A mathematical paper on the relation between the electron frequency and dispersion phenomena in incandescent gases.

E. H. B.

1268. *Interference of the Reflected-Diffracted and the Diffracted-Reflected Rays of a Plane Transparent Grating.* C. Barus and M. Barus. (Phil. Mag. 20. pp. 45-59, July, 1910. Abstract of report to the Carnegie Inst. of Washington.)—[See Abstract No. 678 (1910).]

1269. *Lengths of Focal Lines of Cylindrical Lenses.* A. Whitwell. (Phil. Mag. 20. pp. 69-82, July, 1910.)—A geometrical treatment.

1270. *Formula for Spherical Aberration in a Lens-System.* E. H. Smart. (Phil. Mag. 20, pp. 82-91, July, 1910.)—Mathematical.

1271. *Wave-length Measurements in the Visible Region of the Arc Spectrum.* I. J. M. Eder and E. Valenta. (Akad. Wiss. Wien, Sitz. Ber. 119. 2a, pp. 3-8, Jan., 1910.)—A measurement with the grating of the lines of Welsbach's new elements cassiopeium and aldebaranum. The measurements extend from the red to the yellow-green. E. C. C. B.

1272. *Wave-length Measurements in the Visible Region of the Arc Spectrum.* II. I. J. M. Eder and E. Valenta. (Akad. Wiss. Wien, Sitz. Ber. 119. 2a, pp. 9-41, Jan., 1910.)—In this paper the authors give grating measurements of the spectra of the elements Dy, Tb, neocerium, Gd, neoholmium, Y, Zr, La, and Sa. The wave-lengths are referred to the Rowland-Kayser standards. E. C. C. B.

1273. *New Form of Density, or Opacity-measuring Apparatus.* F. F. Renwick. (Photographic Journ. 50, pp. 177-179, April, 1910.)—Of the tinted wedge-type. Illustrated.

1274. *Spectra of Bismuth.* W. Schwetz. (Zeitschr. wiss. Phot. 8, pp. 301-314, June, 1910.)—A study of the Bi spectra. The wave-lengths of the lines of the spark spectrum between the limits $\lambda=6810$ and $\lambda=4700$ are given as determined with a grating of 1 m. focus. E. C. C. B.

1275. *Arc Spectrum of Zirconium.* A. Bachem. (Zeitschr. wiss. Phot. 8, pp. 316-332, June, 1910.)—The paper contains a complete measurement of the arc lines of Zr between the limits $\lambda=7215$ and $\lambda=2167$ as determined against the Fabry and Buisson standards with a 21-ft. focus concave grating. E. C. C. B.

1276. *The Extreme Red and Infra-red Regions of the Band Spectra of Carbon.* F. Croze. (Comptes Rendus, 150, pp. 1672-1678, June 20, 1910.)—An extension of the measurements of the bands of the three carbon band-spectra (Swan, carbon-oxide, and cyanogen) into the red and infra-red. The heads of the new bands measured in each case conform to the laws of Deslandres. E. C. C. B.

1280. *Control of Light in Spectroscopy with a New Form of Spectrophotometer.* H. E. Ives. (Phys. Rev. 30, pp. 446-450, April, 1910.)—Scattered light when anisotropically distributed over the field of vision detectors very considerably from the accuracy of spectrophotometric work. A simple instrument is described in which the anisotropic distribution of scattered light is reduced to a minimum. E. C. C. B.

1287. *Electron Frequency from Interference.* C. Schaefer. (Ann. d. Phys. 33, 4, pp. 803-805, June 21, 1910.)—A mathematical paper on the relation between the electron frequency and its position phenomena in the different cases. E. H. B.

1288. *Interference of the Reflected-Diffracted and the Diffracted-Reflected Rays.* C. E. Rieu and M. Rieu. (Phil. Mag. 50, pp. 47-52, July, 1910. Abstract of report to the Carnegie Inst. of Washington.)—(See Abstract, Vol. 678 (1910).)

1293. *Interference from Lines of Oblique Lines.* A. W. Whitwell. (Phil. Mag. 50, pp. 55-57, July, 1910.)—A geometrical treatment.

temperature and the mechanical equivalent of heat, the author has calculated from the data obtained the values of α for the various metals and alloys and concludes that for simple bodies this increases with the temperature while for alloys it diminishes. There is an apparent diminution in the value of α with increase of pressure probably due to the use of the mean coefficient of compressibility for a range of pressures in the calculations.

HEAT.

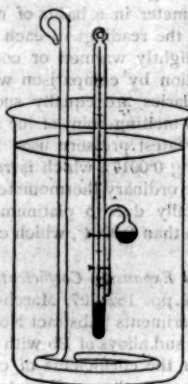
1277. *A Modified Mercury Thermometer.* J. Duclaux and A. Hamelin. (Journ. de Physique, 9, pp. 800-808, July, 1910.)—The variation of the angle of contact of the mercury in the capillary of a thermometer causes jerky movement, and consequent errors especially when temperature is falling. The authors make thermometers, in which (as in the capillary electrometer) there is dilute sulphuric acid above the mercury meniscus. To avoid electrocapillary effects there is a recess full of mercury at the upper end of the capillary, and the mercury in the recess and in the thermometer bulb are connected by a platinum wire on the outside of the thermometer. The instrument thus produced is far more sensitive and accurate for minute changes than the ordinary mercury thermometer, as is shown by the following tests: (1) Raise temperature half a degree or less, then plunge in ice, and in every case the initial reading 0° is obtained with an accuracy of 0.0001° . (2) Plunge the new thermometer in a basin of mercury by the side of an ordinary thermometer, note the readings of each thermometer every minute as the mercury basin is slightly warmed or cooled. The ordinary thermometer has a sluggish action by comparison with the new thermometer. Flat- and round-bore capillaries are equally successful. (3) A searching experiment is to observe the melting-point of ice under small + or - variations in pressure. The greatest pressure used is $1/8$ atm., the resultant change in fusing-point being 0.0017° , which is regularly given by the new instrument, but to which the ordinary thermometer is quite insensitive. The electrocapillary forces actually due to platinum-mercury or mercury-acid would produce errors of less than 0.0004° , which can be ignored. P. E. S.

1278. *Compressibility and Expansion Coefficients of Metals and Alloys.* S. Lussana. (N. Cimento, 19, pp. 182-207, March-April, 1910.)—The author has extended his earlier experiments [Abstract No. 2916 (1904)] to Al, Bi, Sb, tin amalgam, lead amalgam, and alloys of Pb with Zn or Sn, of Zn with Cd or Al, and of Cu with Al or Zn, the coefficients of compressibility being given for each, and also in many cases the coefficients of expansion at different pressures. For Al and Bi the coefficients follow the rules previously given, but for Sb the coefficient of expansion diminishes slightly with rise of temperature at a pressure of 1500 atmos. The alloys examined do not obey the law of mixtures, but in general the compressibility of the alloys increases with the temperature, and the coefficient of expansion diminishes with the pressure. Diagrams are given in which the compressibility curve for Sn-Pb alloys is shown to be almost parallel to the melting-point curve; the compressibility curves for alloys of Zn-Cd and Zn-Al are compared with the corresponding hardness curves, and that of Cu-Al alloys with the corresponding thermoelectric power curve. For Zn-Al alloys water acts most energetically on those containing 40 per cent. Al. When a Zn-Al alloy is placed in water under pressure, decomposition takes place at the same rate as at atmospheric pressure, but the liberated hydrogen does not expand appreciably, and only gradually escapes when the pressure is removed, appearing to be either condensed as a film on the alloy, or partially dissolved in it. Applying the formula $c_p - c_v = -T/J(dv/dT)_p/(dv/dp)_p$, where T is the absolute

temperature and J the mechanical equivalent of heat, the author has calculated from the data obtained the values of $c_p - c_v$ for the various metals and alloys, and concludes that for simple bodies this increases with the temperature, while for alloys it diminishes. There is an apparent diminution in the value of $c_p - c_v$ with increase of pressure, due probably to the use of the mean coefficient of compressibility for a range of pressures in the calculations.

W. H. St.

1279. *Method for determining Boiling-points under Constant Conditions.* A. Smith and A. W. C. Menzies. (Amer. Chem. Soc., Journ. 32. pp. 897-905, Aug., 1910. Roy. Soc. Edinburgh, Proc. 30. pp. 432-435, 1910. Abstract.)—The authors have devised a method for determining boiling-points of solids and liquids, which requires only very little material and involves easily reproducible conditions. The apparatus consists of a tiny bulb (see Fig.) with a bent capillary not less than 1 mm. in diam. This is attached to a thermometer and suspended in a beaker. The latter contains water, sulphuric acid, melted paraffin, &c., according to the temperature required. After charging with about 0.08 to 0.1 gm. substance, the bulb is



attached to the thermometer, and submerged in the liquid; the bath is then heated. When the temperature has remained at the boiling-point for a few moments, dissolved and occluded gases and moisture have all been expelled, and a rapid stream of pure vapour issues. In case the substance is insoluble in the bath liquid, the bubbles of vapour rise to the surface. With falling temperature and vigorous stirring the point at which the bubbles suddenly cease can be read accurately; this is the boiling-point. In the case of mutual solubility of the substance and the bath liquid the point at which boiling ceases cannot be determined sharply. In this case the bath liquid is allowed to recede into the capillary to a point 5-10 mm. from the opening, opposite to some mark on the thermometer or binding thread. The temperature at which this point is reached is the boiling-point. The barometric height (at 0°) must be recorded. A correction for the head of liquid above the opening of the capillary, or the mark to which the bath liquid ascends, is required. The immersed depth is measured to within ± 2 mm., and taking into account the sp. gr. (numbers for sulphuric acid, paraffin, mixture of

sodium and potassium nitrates are given) of the bath liquid at the temperature concerned is converted into mercury height and added to the barometric reading. The values obtained with a number of substances agree exceedingly well with those obtained by the distilling flask method. **A. F.**

1280. Specific Heats of Air and Carbon Dioxide at Atmospheric Pressure by the Continuous Electric Method at 20° C. and 100° C. W. F. G. Swann. (Roy. Soc., Phil. Trans. 210, pp. 199-288, March 29, 1910. Proc. Ser. A: 82, pp. 147-149, May 6, 1909. Abstract.)—A constant stream of gas is passed, through a tube into a jacket, where it is heated by an electric current C, passing through a Pt coil, the rise in temperature being measured by means of two Pt thermometers used differentially. If E is the p.d. between the ends of the coil, then $CE = JSQ\theta\theta + h\theta\theta$, where Q is the mass of gas passing through per sec., and S is its specific heat. By reducing the rate of flow to one-half and adjusting the current so that the rise in temperature is the same, the term $h\theta\theta$ is eliminated. The air was pumped continually through the apparatus by bellows worked by an adjustable crank, driven by a wheel connected to a motor. It was next passed through various drying tubes to an automatic pressure regulator, and then through a number of fine metal tubes into the calorimeter. The rate of flow of the gas was obtained in terms of the mean pressure in the fine metal tubes and the pressure-difference between their ends, the tubes being arranged in parallel. After applying various corrections it was found that the specific heats of air at 20° C. and 100° are respectively 0.24178 and 0.24801 in terms of the gm. calorie at 20° C. The corrections which had to be applied amounted to 1.5 parts per 1000 at 20° C. and 2.9 parts per 1000 at 100° C. The value of the specific heat of air at 50° C. is about 2 per cent. higher than that obtained by Regnault. For CO₂ the author finds $S = 0.20202$ at 20° C. and 0.22141 at 100° C. For this gas the author's result at 50° C. is only about $\frac{1}{10}$ per cent. lower than that of Holborn and Henning. Holborn and Henning, however, find an increase in S of 0.0188 for a temperature-rise of 100° C., whereas the present author gets 0.240. **W. C. S. P.**

1281. Saturation Pressure of Water-vapour above 200°. L. Holborn and A. Baumann. (Ann. d. Physik, 81, 5, pp. 945-970, April 5, 1910. Communication from the Physikal.-Techn. Reichsanstalt.)—An account of experiments made by the statical method up to the critical temperature. The water-vapour was generated in a steel cylinder of 40 cm.³ capacity, with an external diam. of 5.5 cm. and a bore of 2 cm. Up to 230° the water in the steel cylinder was heated electrically by means of a nickel resistance; for the higher temperatures an electrically heated saltpetre bath was used. For the pressure measurements a specially constructed pressure balance was used and the temperatures were measured by means of a Pt thermometer. The authors find that the critical temperature is 374° C., which agrees with the result of Traube and Teichner by the meniscus method. The corresponding value of the critical pressure is 225 atmos. (kg./cm.²). **W. C. S. P.**

1282. Inner Cone of the Bunsen Flame. F. Haber [and B. S. Lacy]. (Zeitschr. Phys. Chem. 68, 6, pp. 726-752, Jan. 14, 1910.)—The author discusses previous work on this subject [compare Haber and Richardt, Abstract No. 815 (1904); Davidson, Abstract No. 559 (1906); Tufts, Abstract No. 1098 (1906); Lacy, Abstract No. 659 (1909); Haber and Hodsman, Abstract No. 684 (1910)]. The results show that, when the supply of air is abundant, the green

inner cone of the Bunsen flame exhibits relatively high conductivity, the latter diminishing extremely rapidly as the luminous portions of the flame are approached. Also, at the limit of the inner cone and the intermediate gas the velocity with which the water-gas equilibrium is attained diminishes very considerably. The author is of opinion that the catalysis of the water-gas equilibrium is related to conductivity and luminosity (Tufts, *loc. cit.*), the gas ions, which result from the chemical changes occurring in the luminous zone, acting catalytically. T. H. P.

1283. *New Determination of the Mechanical Equivalent of Heat.* L. Risatti. (Annal. Chim. Phys. 20, pp. 417-432, July, 1910.)—The author has carried out a new determination of the mechanical equivalent of heat. The conversion of mechanical work into heat took place in the cavity of a Bunsen calorimeter placed in a Dewar vessel filled with melting ice. A full description of the apparatus is given. The mean value of the equivalent from ten determinations is 4268.4 gm.-cm. or 4.1851×10^7 ergs. In this value the 8 may be considered exact, and the 5 probable. A. F.

1284. *Union of Hydrogen and Oxygen in Flame.* H. B. Dixon. (Chem. Soc., Jour. 97, pp. 661-677, April, 1910.)—The author gives a résumé of the work published on this subject. Falk's experiments [Abstracts Nos. 670 (1907); 428 (1908)] have been repeated, and the explosion produced by the adiabatic compression photographed, the results showing that the flame starts from a point and that, in the more slowly burning mixtures, the spread of the flame throughout the gas takes an appreciable time. Further, the ignition-point can be made to vary by altering the velocity of the piston. In the author's experiments, the error due to movement of the piston during the "pre-flame" period of self-heating was avoided by arresting the descent of the piston artificially the moment the gases were brought to the self-heating temperature. For electrolytic gas the ignition-point found agrees closely with that obtained by Falk, so that, with this mixture, the period of flameless combustion must be very short and the spread of the flame very rapid. The mixture containing equal volumes of the two gases has a lower ignition-point than electrolytic gas, but it is not the mixture of "maximum affinity," the further addition of oxygen resulting in a regular lowering of the ignition-point. The author therefore submits that the ignition-points of mixtures of hydrogen and oxygen do not prove that hydrogen peroxide is the first product of the reaction. T. H. P.

1285. *Value of the Constant in Stefan's Formula.* E. Bauer and M. Moulin. (Journ. de Physique, 9, pp. 468-490, June, 1910. Paper read before the Soc. Franç. de Physique, Dec. 8, 1909.)—With the usual notation Stefan's law may be written $E = \sigma T^4$. Values for σ , varying from 4.6 to 6.3, have been given. A new determination is therefore of value. Two methods have been employed. In the first, attempts have been made to measure the energy radiated from a black body cooling *in vacuo*. In the second, the energy radiated from a hot black body to a colder black body acting as a receiver is measured. The authors adopt the latter method. A black body of the Lummer and Brodhun type is placed in an Herzeus furnace. Assuming that the temperature of melting gold is 1064°C , the authors find that $\sigma = 5.8 \times 10^{-12}$ (watt cm.⁻² degree⁻⁴). The max. inaccuracy of the measurement is of the order of 1 per cent. The absorption of the radiation by the vapour and CO₂ in the air is very small and does not affect the value given. A. R.

1286. *Theory of Radiation.* J. J. Thomson. (Phil. Mag. 20, pp. 228-247, July, 1910.)—In a former paper [see Abstract No. 1660 (1907)], the author developed a theory of radiation regarded as arising from impact between negative electrons and material molecules, and showed that the requisite conditions would be satisfied if the collisions were regarded as taking place between the electrons and systems of constant type dispersed through the molecules such as to give rise to repulsive forces varying inversely as the cube of the distance between an electron and a system, during the period of the collision. Forces of this type would be exerted by electric doublets of constant moment with their negative ends pointing to the electrons. The calculations here given show that this theory leads to the same law for the energy of radiation in the case of long waves as those of Rayleigh and Planck. In the case of short waves the law does not agree with Rayleigh's, but is practically identical with that obtained by Planck. It is shown that the existence of these doublets would account for phenomena, such as those observed by Ladenburg, which are capable of interpretation as indicating that the energy in radiation is made up of finite indivisible units, an interpretation which, in the author's opinion, is open to grave objections. It is shown in the first place that if AB be a doublet with the positive end at B, and P be an electron, then it is possible to have a state of steady motion in which P describes a circle round AB as axis, the plane of the orbit being at right angles to AB and its centre on the prolongation of AB. The kinetic energy of the electron in steady motion will then be proportional to the frequency of the motion. If an electric wave of definite frequency were to traverse a body containing such systems it might do work upon any doublet, twisting its axis so as to alter the angle it makes with the radius to the electron. By the principle of resonance such alteration will be greatest when the frequency of the steady motion coincides with that of the wave. Now, a sufficiently large alteration in the angle will set the electron free from the influence of the doublet, and the former will carry with it much the same kinetic energy as it had in the steady motion, the value of which is the product of the frequency by Planck's constant. The number of atoms in which there is steady motion of this kind of any given frequency could hardly form more than an extremely minute proportion of the whole, so that the number of particles emitted would, on any view of the constitution of a light-wave, be small in comparison with the number of molecules passed over by the light. The systems of electrons in steady motion under the influence of the doublets may be regarded as a system of resonators, having frequencies of all values, and each possessing an amount of energy proportional to its own frequency. The magnetic properties of bodies appear to show that the whole number of these systems in steady motion for the whole range of frequencies cannot be large compared with the number of atoms. If, e.g., there were as many as one system per atom, the sum of the resulting magnetic moments per cm.³ of gas at standard temperature and pressure would, taking the number of molecules per cm.³ as 8×10^{19} , amount to 0.8, which is about half the value of this quantity in the case of oxygen, the most magnetic gas known. G. W. DE T.

1287. *Relation between the Temperature and Resistance of Nickel.* C. F. Marvin. (Phys. Rev. 30, pp. 522-528, April, 1910.)—For work at high temperatures no metal can compete with Pt for the construction of resistance thermometers. The author suggests that, on account of its greater resistance and temperature-coefficient and also small cost, nickel could be used with advantage over a considerable range of temperature. The variation of the

resistance of nickel with temperature seems to be represented by a logarithmic curve of the form $\log R = a + mT$. Only two points are required to locate this curve, whereas, in the case of the Pt curve, three are required. By means of a suitable bridge the relation between the resistance and the reading on the bridge-wire may be made to be nearly logarithmic. The reading of the bridge-wire will thus give the temperature on the gas scale directly.

W. C. S. P.

1288. Applicability of the Law of Corresponding States to the Joule-Thomson effect in Water and Carbon Dioxide. H. N. Davis. (Amer. Acad. Proc. 45. No. 8. pp. 248-264, March, 1910. Contribution from the Jefferson Physical Lab., Harvard Univ.)—In order to obtain an indirect determination of the absolute thermodynamic scale above 100° , it is usually assumed that, at least with the gases hydrogen, oxygen, nitrogen, CO_2 , and air, the Joule-Thomson effect obeys the law of corresponding states—that is, if the Joule-Thomson coefficient for each gas is expressed in terms of the critical pressure and temperature of that gas as units and the results are plotted against the temperature expressed in the same "reduced" units, the curves obtained will be identical for all five gases. The author shows that the law of corresponding states is verified for CO_2 and water within the limits of error of the available observations on water. The fact that water, although anomalous in many ways through association, obeys the law of corresponding states as to its Joule-Thomson effect, renders it more probable that the permanent gases will also obey this law.

T. H. P.

1289. Evaporation from the Surface of a Solid Sphere. H. W. Morse. (Amer. Acad. Proc. 45. No. 14. pp. 868-867, April, 1910.)—The author has followed the evaporation at constant temperature of spheres of iodine of $1-0.2$ mm. radius in a large box with glass sides, the two side doors being left open before each series of readings so as to allow free circulation of air. The results show that, for spheres of iodine varying in mass from 2 mgm. to very small values, the rate of evaporation is accurately proportional to the radius. The spherical shape of the grains is maintained practically unchanged until the sphere finally disappears completely.

T. H. P.

number of molecules passed over by the light. The influence of the refractive index of the medium on the evaporation rate has been investigated.

REFERENCES.

1290. Boltzmann's Law of Probability $e^{-E/kT}$. S. H. Burbury. (Phil. Mag. 19. pp. 712-714, May, 1910.)—Mathematical.

1291. Inversion-points for a Fluid passing through a Porous Plug; their Use in Testing proposed Equations of State. II. An Examination of Experimental Data. A. W. Porter. (Phil. Mag. 19. pp. 888-897, June, 1910.)

1292. Impossibility of certain Waves of Shock and Combustion. E. Jouguet. (Comptes Rendus, 150. pp. 91-93, Jan. 10, 1910.)—[See Abstract No. 679 (1907).]

The author has shown that the law of corresponding states is not applicable to the case of shock waves and combustion. The author suggests that on account of its greater resistance to compression, the law of corresponding states is not applicable to the case of shock waves and combustion. The author suggests that on account of its greater resistance to compression, the law of corresponding states is not applicable to the case of shock waves and combustion.

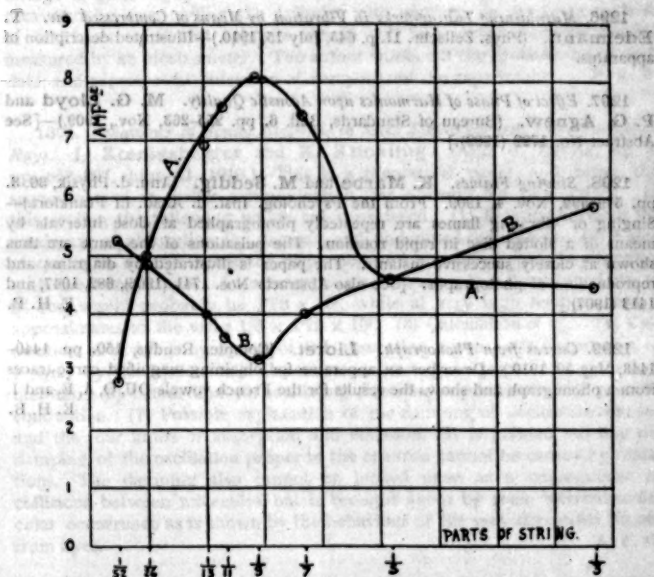
reached when the string is struck at $1/9$ of its length from the fixed point. For the same string ($C = 257$) two English pianos had the striking point at $1/8$ and $1/8$ respectively, and a German piano $1/8$.

SOUND.

1293. *Vibration of Violin String and Belly.* E. H. Barton and T. J. Richmond. (Phil. Mag. 18, pp. 233-240, Aug., 1909.)—After studying the vibration curves of a monochord string [see Barton and Penzer, Abstracts Nos. 448 and 1086 (1907)] a violin was mounted in such a position that the vibration of the string, the belly, and the air issuing from it could be recorded separately. The curves are published. They are smoother than the monochord curves. This may be due to the fundamentals being attended by a fuller retinue of upper partials, none of which is unduly prominent.

E. E. F.

1294. *Striking Point of Pianoforte Strings.* G. H. Berry. (Phil. Mag. 19, pp. 648-651, April, 1910.)—The vibration curves of a piano-wire mounted on a sounding-board in the manner usual in the piano, and struck by a piano hammer at various distances from the bridge were photographed. The results



are plotted in the diagram, where A represents the amplitude of the forced vibration of the sounding-board produced by the string, and curve B gives the amplitude of the natural vibration of the sounding-board. It is the aim of the pianoforte-maker to obtain the max. effect from the string and minimum effect from the natural period of the sounding-board. This is

reached when the string is struck at $1/9$ of its length from the fixed bridge. For the same string ($C = 261$) two English pianos had the striking-point at $1/8.4$ and $1/8.3$ respectively, and a German piano $1/8.5$. E. E. F.

1295. *Harmonics of Brass Instruments*. G. Sizes and G. Massol. *Comptes Rendus*, 151. pp. 808-805, July 25, 1910.—Contrary to the usual description to brass instruments of the harmonic scale only of open notes, these authors find other notes possible. Thus, with a B $\flat$ cornet they claim to find the following notes, three being graver than the nominal note which is in square brackets.

Frequencies: 29, 58, 87, [116], 174, 232, 261, 290, 348.

Notes: si $\flat$, si $\flat$, fa $\flat$, [si $\flat$], fa $\flat$, si $\flat$, ut, re $\flat$, fa $\flat$.

They also found additional notes with the trombone and the horn. E. H. B.

1296. *Maintaining Tuning-forks in Vibration by Means of Compressed Air*. T. Edelmann. (*Phys. Zeitschr.* 11. p. 645, July 15, 1910.)—Illustrated description of apparatus.

1297. *Effect of Phase of Harmonics upon Acoustic Quality*. M. G. Lloyd and P. G. Agnew. (*Bureau of Standards, Bull.* 6. pp. 255-263, Nov., 1909.)—[See Abstract No. 1729 (1909).]

1298. *Singing Flames*. K. Marbe and M. Seddig. (*Ann. d. Physik*, 80. 3. pp. 579-592, Nov. 4, 1909. From the *Psycholog. Inst. d. Akad. in Frankfurt*).—Singing or vibrating flames are repeatedly photographed at close intervals by means of a slotted disc in rapid rotation. The pulsations of the flame are thus shown at closely successive instants. The paper is illustrated by diagrams and reproductions of photographs. [See also Abstracts Nos. 1741 (1906), 682, 1047, and 1418 (1907).]

1299. *Curves from Phonograph*. Lioret. (*Comptes Rendus*, 150. pp. 1440-1443, May 30, 1910.)—Describes an apparatus for obtaining magnified curve-traces from a phonograph and shows the results for the French vowels OU, O, A, É, and I.

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ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1300. *An Experiment concerning the Electrodynamics of Moving Bodies.* M. Born. (Deutsch. Phys. Gesell., Verh. 12, 10, pp. 457-487, May 30, 1910.)—Describes a proposed experiment to discriminate between the theories applied to moving bodies by Lorentz and Minkowski respectively [see Abstract No. 1990 (1908)]. A metallic cylinder is placed with its axis in the magnetic meridian and made to turn with constant speed. On joining the axis and a point on the circumference through a wire, a current, due to unipolar induction, traverses the wire. If the wire is removed and the axis is earthed, the circumference acquires a charge, and this charge is, in Minkowski's theory, proportional to H , whereas in Lorentz's theory it is proportional to B . This means that in the case of Minkowski's theory the charge is quite independent of the material of the cylinder. It may be measured by surrounding the cylinder with another, on the inner surface of which an equal and opposite charge will be induced, and this can be measured by an electrometer. The author works out the probable numerical data, and expresses his intention of carrying out the experiment. E. E. F.

1301. *Behaviour of Bound Electrons in Solid Bodies towards Electromagnetic Rays.* J. Koenigsberger and K. Kilchling. (Ann. d. Physik, 82, 4, pp. 848-887, June 21, 1910.)—This is a theoretical paper, and forms the second part of an earlier communication [see Abstract No. 1904 (1909)]. In this section the following points are considered: (1) Relation between the maximum of absorption for damped and undamped oscillations. (2) Value of e/m from determinations of dispersion and absorption and its alteration with the temperature. An attempt is made to show that the value of e/m at 0° abs. would probably be 1.78×10^7 , while at very high temperatures it approximates to the value $1/8 \times 1.78 \times 10^7$. (3) Calculation of λ_m . (4) Calculation of ϕ (e/m) by means of the absorption curve. (5) Calculation of ϕ (e/m) by absorption and dispersion according to Jamin and Quincke's method. (6) Calculations for oscillating electrons in substances with metallic conduction. (7) Possible explanation of the damping of oscillations proper and the four kinds of absorption and emission. It is pointed out that the damping of the oscillation proper to the electron cannot be caused by radiations. The damping also cannot be looked upon as a consequence of collisions between molecules, but is brought about by some internal molecular occurrence as is shown by the behaviour of the very attenuated vapour from dyes. A. E. G.

1302. *Atmospheric Electricity at Kalocsa.* A. Wagner. (Akad. Wiss. Wien, Sitz. Ber. 118, 2a, pp. 1625-1656, Dec., 1909.)—Three series of observations, extending over 3 or 6 weeks, were made by the author, morning, noon (2 to 3 p.m.), and evening on the flat roof of the Kalocsa Observatory, which is situated in the low plains of Hungary, east of the Danube, 60 m. above sea-level. Kalocsa lies in the Sárköz, a long belt of fertile soil, stretching north

to south along the Danube and Theiss Rivers, and covered with 0.5 m. of a layer of vegetable earth; 25 km. east of this is an area of drifting sands. The dissipation values were high on the whole, but lower with east wind from that sand region. The general results are in agreement with those of Elster and Geitel (whose instruments were used), Zölls, Mazelle, and Simpson. The dissipation increased with rising temperature and with increasing cloudiness of the sky; the latter increase was less marked when the sky was already overcast. The dissipation of negative electricity predominated decidedly, q being 1.47. There was a maximum in the early afternoon, and a minimum in the morning and evening; the predominance of negative electricity was less marked about noon. The number of ions was also very high. H. B.

1303. *Atmospheric Electricity Observations at Graz.* H. Benndorf. (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 89-100, Jan., 1910.)—The paper gives a description of the station established near Graz for the continuous registration of potential gradient, the charge carried by rain, and the conductivity of the atmosphere. As it is hoped that the station may serve as a model for others to be erected in remote regions, special consideration was devoted to the problem of equipping the station so that it should be independent of gas, water, or electric supplies, or of the necessity for having a skilled mechanic within easy reach. The construction of the hut is first described. For recording potential gradient two Benndorf electrometers are used, one having a scale value of 10 volts/mm., capable of recording up to 500 volts, the other with a scale value of 55 volts/mm., capable of recording up to 2800 volts. For recording the charge brought down by rain, two collectors are used, which are exposed alternately for intervals of 10 min., the mechanism for covering and uncovering them being actuated by a weight. The collecting vessel is by this means brought inside a conductor, which is closed by a lid at the moment when the charge is measured. The total precipitation and the total charge collected during the 10-minute interval that the collector was exposed are recorded. The conductivity of the air is recorded by measuring the rate of leak from a 24-m. long insulated wire, which is charged at intervals of $8\frac{1}{2}$ min. alternately to +50 and -50 volts. The exposed wire is screened from the earth's field by surrounding it with a galvanised iron network of coarse mesh, distant at least 50 cm. from the wire. R. G. K. L.

1304. *Earth-Air Electric Current and Atmospheric Potential Gradient.* G. A. Carse and D. MacOwan. (Roy. Soc. Edinburgh, Proc. 80. pp. 460-465, 1909-1910.)—Tests made in and around Edinburgh by means of a Wilson portable gold-leaf electrometer show a gradual increase in the dissipation factor [see Abstract No. 1461 (1908)] as the distance from the central part of the town increases. The fact that the dissipation per cent. per min. was only 0.8 to 1.2 in the town air, and as much as 1.5 to 8.6 in the country air, is probably due to the loading-up of the ions by their becoming attached to dust particles, &c. The following results were deduced from the observations: Average potential gradient about 190 volts/m., conductivity of the air 2×10^{-6} e.s. unit, charge of the earth -2.56×10^{18} e.s. unit, and potential -1.21×10^9 volts. A. D. R.

1305. *Earth-Air Electric Currents.* G. C. Simpson. (Phil. Mag. 19. pp. 715-725, May, 1910. Paper read before the Physical Soc., March 11, 1910.)—An account of observations made at Simla, using an arrangement for

automatically recording the current. The mean value found for the conductivity of the air, viz., 5.8×10^{-1} e.s. unit, agrees well with that given by other workers. I got no exact identity, by comparing with the results of L. H. W. 1308. *Measurement of the Radio-active Radiation of High Permeability present in the Atmosphere.* H. Mache. (Akad. Wiss. Wien, Sitz. Ber. 119. 2a, pp. 55-87, Jan., 1910.)—The observations form the continuation of work done in 1906 [Abstract No. 1868 (1906)]. A charged electrode was shielded from all but the most penetrating radiations by placing it in a large box made of thinnest sheet zinc, 1.5 m. high and 1 m.² in cross-section, the box being supported on four posts 2 m. high. An electroscope was connected to the electrode, which was then charged to 220 volts. The observations consisted in noting the time required for the potential to fall to 212 volts. The reciprocal of this time is taken as proportional to the intensity of the radiation. The intensity is subject to very rapid variations, so that each entry in the register corresponds with at least three, and often more, separate observations. The hours for observing were 8 a.m., 2 p.m., and 8 p.m. The observations, which were made at Innsbrück, extended over the period Oct. 1, 1907, to Oct. 15, 1908. From Dec. onward, the potential gradient was also recorded with a Benndorf electrometer. The detailed readings are given in an appendix. Results: (1) The intensity of the radiation shows a distinct annual period, with a maximum in autumn. The diurnal variation shows a maximum at the hour of morning observation, which reappears in the results for each month. The figures for the whole year are: 8 a.m., 81; 2 p.m., 67; 8 p.m., 68. (2) In considering the effect of wind-force, the days of Föhn were treated separately. For them the radiation decreases considerably as the wind increases; winds of force 1 correspond with radiation of intensity 70, while winds of force 5 give a radiation intensity of 47. On other days no definite relation could be established between wind-force and radiation intensity. (3) Analysis of the results by wind directions showed that W. and SW. winds blowing along the Inn valley gave the highest intensity, while S. winds (Föhn) gave the lowest values. (4) No connection could be traced between radiation intensity and the absolute height of the barometer. (5) Analysis according as the barometer was rising, steady or falling, revealed no conspicuous differences for these three states during the summer months. In winter (snow lying), days of rising barometer gave a radiation intensity 57, whereas days of falling or steady barometer each gave the much higher value 75. (6) Likewise the effect of precipitation was practically negligible in summer, but in winter (snow) the radiation intensity was reduced to 58 for days of precipitation, whereas for other days the mean value is 78. (7) In tracing a connection between radiation intensity and potential gradient, complications are introduced by the diurnal variation. If only the afternoon and evening observations are considered, the radiation intensity shows a fairly regular increase from 68 for gradients of less than 60 volts/m. to 86 for gradients between 120 and 150 volts/m. R. G. K. L.

1307. *Atmospheric Electricity.* E. Kidson. (Terrestrial Magnetism, 15, pp. 88-91, June, 1910.)—A summary is given of the observations made during the first cruise of the survey ship *Carnegie*. These include the records of specific conductivity of the atmosphere and the detection of radio-active emanations on the journey between Falmouth-Madeira, Madeira-Bermuda, and Bermuda-New York. Alternate days were devoted to conductivity and radio-activity observations, but the programme was interfered with by bad

weather and by the failure on some occasions of the Zamboni (dry pile to charge the collecting wire. It was found that a definite reduction of conductivity was caused by the presence of visible haze or fog, but rain squalls of short duration did not produce any effect. Low conductivity was also characteristic of stations in close proximity to the land. Positive conductivity was generally in excess over negative, this being probably due to the accumulation of positive ions near the earth's negatively charged surface. The radio-activity experiments indicate that there is little or no evidence of thorium emanation in places far removed from land, and it is suggested that when detected over the sea it is derived from air-currents which have recently passed over land surfaces. C. P. B.

DISCHARGE AND OSCILLATIONS.

1308. *Effect of Small Traces of Water-vapour on the Velocities of Ions produced by Röntgen Rays in Air.* R. T. Lattey. (Roy. Soc., Proc. Ser. A. 84, pp. 173-181, July 28, 1910.)—Some experiments of Townsend [see Abstract No. 518 (1909)] on the lateral diffusion of a narrow stream of ions moving in an electric field led to the conclusion that negative ions in perfectly dry air are much smaller than those in air containing a small quantity of moisture. It is consequently to be expected that the complete removal of water-vapour would cause an increase in the velocity with which negative ions move under the influence of an electric field of force. An investigation of the velocities of the ions in air at low pressures shows that while the complete removal of water-vapour has only a small effect on the velocities of positive ions, yet the same cause increases the velocities of the negative ions by a factor varying between 2 and 80 for the range of pressures and electric forces used in these experiments. The method adopted is to let the ions travel between two gauzes under a known electric force for a time " t ," and then to reverse the field. If v is the velocity of the ions, and d the distance between the gauzes, then ions starting from one gauze will reach the other if $t < d/v$. If t is gradually decreased, it is possible to find, by means of an electrometer, when ions cease to reach the second gauze; when this happens $v = d/t$. The apparatus used is fully described. If X = electric force, p = air pressure, and v = velocity of ions, then for positive ions in dry air it is found that vp/X is 1121, a result in good agreement with those obtained by other observers. After admitting moisture vp/X is only 780. The comparatively large effect produced here compared with those observed by Zelený, Przibram, and Chattock is probably due to the much larger percentage of water-vapour admitted in this experiment. The velocities observed in the case of negative ions in dried air are greatly in excess of those observed by former experimenters. The velocity is apparently a function of X/p , which is independent of the actual values of either X or p . By extrapolation the value of v for dry air is found to be 7500 cm. per sec., while with moist air it is only 1802 cm. per sec.; the gas pressure being 18.2 mm., and X 2.14. With very moist air values of vp/X are obtained ranging from 890 to 1070. Zelený has obtained similar results, but his work was done with values of X and p very different from those here used. Przibram also obtained the value 1005 for ions in moist air, and 1160 in air partially dried by sulphuric acid. A. E. G.

1809. *Magnetic Rays.* L. Silla. (N. Cimento, 19, pp. 149-176, March-April, 1910.)—Investigates in further detail the quantitative aspects of Righi's

magnetic rays [Abstracts Nos. 874 and 2090 (1909)]. The doublets, each composed of a positive ion and an electron revolving round it, are very short-lived, but their life is prolonged by the magnetic field. The distance between the centre of the ion and the electron must be greater than 0.5×10^{-8} cm., and greater than 10^{-6} or 10^{-5} in the strong magnetic fields used by Righi. Beyond these limits the doublets are unstable. The distances pass from one limit to the other in a time-interval of the order of 10^{-10} sec., during which the doublet traverses a distance of about 1 mm. E. E. F.

1310. *Magnetic Rays*. A. Garbasso. (N. Cimento, 19, pp. 880-884, May, 1910.)—A mathematical study of the effect of a magnetic field upon the orbit of an electron moving round an attracting centre in a plane normal to the field. The angular velocity is $AHc/2m$, with the usual meaning of the symbols. E. E. F.

1311. *Observations on Canal Rays*. J. Koenigsberger and J. Kutschewski. (Deutsch. Phys. Gesell., Verh. 12, 13, pp. 538-543, July 15, 1910.)—It is concluded from this research that relative to the emission of light by canal rays, the following results and possibilities may be arrived at: The emission of light is brought about by the collision of quickly-moving neutral atoms and molecules with other neutral particles (molecules at rest). At the same time an ionisation is occasioned, and the following three cases are then possible: (1) The ionisation is a casual accompanying phenomenon. The emission of light proceeds from the violently shaken atom or molecule which has gained a large internal kinetic energy. Perhaps also a chemical dissociation of the molecules takes place. (2) The emission of light takes place owing to ions formed by collision. (3) The emission of light takes place only at the instant of splitting up into ions. A. E. G.

1312. *The Electric Arc under Reduced Pressure*. H. Buisson and C. Fabry. (Comptes Rendus, 151, pp. 228-225, July 18, 1910.)—The stability of the arc between poles of a difficultly volatile metal such as Fe, depends upon the presence of some molten oxide upon the kathode. If this oxide be present the arc is stable even under reduced pressure. If the arc is burning in an atmosphere of hydrogen, it is stable until the oxide is entirely reduced, when the flame at once becomes unstable. The relation between the p.d., between the poles, and the current and pressure is complex. For example, if the distance between the poles and the current are kept constant and the pressure decreased, the potential passes first through a minimum, then a well-marked maximum, and then again decreases, this decrease being linearly related to the decrease in pressure. E. C. C. B.

1313. *Electrical and Spectroscopic Properties of the Arc between Metal Poles*. C. Fabry and H. Buisson. (Comptes Rendus, 150, pp. 1674-1676, June 20, 1910.)—A further study of the arc, especially between iron poles. It has already been noted that there are two different types of discharge: in one, which is the usual form at atmospheric pressure when the current exceeds 2 or 3 amps, the spark lines appear at small bright points on each electrode; in the other type these spark lines disappear entirely from the anode, and the p.d. between the two electrodes is increased to about 12 volts. The transition from one type to the other is very sharply marked, and it is found that the second type is obtained much more easily as the pressure is reduced.

In the second type also there is present close to the anode the band-spectrum of nitrogen, but the distribution of intensities among the bands is not the same as in the case of the vacuum-tube spectrum of the gas. The region of the arc exhibiting the bands is a well-defined and small one near the anode. This region becomes more extended with decreasing pressure, and undergoes some remarkable changes. This luminous region divides into a number of smaller spherules, which, owing to their mutual repulsion, seem to be charged with electricity.

E. C. C. B.

1314. *Theory of the Luminescence of the Mercury Arc in a Vacuum.* A. Perot and J. Bosler. (*Comptes Rendus*, 151. pp. 216-218, July 18, 1910.)—Perot [see Abstract No. 1128 (1910)] has recently concluded that the luminous centres in the mercury arc are distinct from the electric carriers. The velocity of the latter is about 2400 m./sec., whilst spectroscopic observations show that the velocity of the former varies from 40 to 400 m./sec., depending on the pressure. The authors show theoretically how the velocity of the luminous centres can be deduced from that of the electric carriers. The following hypotheses are made: It is assumed that the emission of spectral rays by the electric carriers is either zero or exceedingly small. It is also assumed that the emission is due to mercurial atoms ionised and put in vibration by the shock of the electric carriers.—The agreement between the calculated and observed numbers is satisfactory.

A. R.

1315. *Electrical and Optical Measurements of the Glow Discharge in Sodium and Potassium Vapours.* G. Gehlhoff and K. Rottgardt. (*Deutsch. Phys. Gesell., Verh.* 12. 12. pp. 492-505, June 80, 1910.)—Under the influence of an electric current, potassium vapour and sodium vapour completely absorb at certain temperatures all gases, even hydrogen. Potassium acts quicker in this than sodium. Complete absorption takes place when a current passes in the presence of potassium vapour at 175° C., and with sodium vapour at 290°. The cathode-fall in the residual gas and the total p.d. between cathode and anode reach a minimum at the beginning of the absorption. With potassium vapour the cathode-fall is 80 volts, and with sodium vapour 115 volts about. In different parts of the glow discharge the emission spectrum is different. In the anodic glow the principal and secondary series are emitted; in the positive column the principal series. In the negative glow with potassium, at lower temperatures, the secondary series is emitted; above 280° the secondary series and Goldstein's ground spectrum; above 800° the principal series makes its appearance. In sodium vapour in the negative glow the principal and secondary series are visible; at higher temperatures the secondary series, all but the green line, vanishes, the halo becoming stronger.

A. E. G.

1316. *Point Discharge in Air under Pressure.* O. A. Gage. (*Phys. Rev.* 80. pp. 720-789, June, 1910.)—The two electrodes were formed by a carefully insulated wire passing through the middle of a hollow metal cylinder, and a discharge between them was maintained by an influence machine capable of giving a p.d. of 25,000 volts. For currents of 10 to 400 microamps, the relation between the current i and the p.d. V follows the equation $i^{\frac{1}{2}} = A(V - M)$, where A is a constant and M the minimum potential of discharge. Pressure has a very great influence on the true point-discharge, due both to an increase in minimum potential and to a decrease in the velocity of the ions. The curves obtained indicate that the velocities of the positive and negative ions

become more nearly equal at high pressures (up to 17 atmos.). For a given current the corresponding voltages vary as the square root of the pressures, and the current given by a constant p.d. varies as the pressure. G. E. A.

1317. *Characteristics of a Vacuum Tube.* S. Marsh. (Ann. d. Physik, 82. 2. pp. 438-458, May 12, 1910. Extract of Dissertation, Göttingen.)—Curves were traced to indicate the connection between p.d. and current in a vacuum tube provided with a Wehnelt kathode capable of being heated by an independent current. The Wehnelt kathode consisted of a loop of thin Pt-wire coated with CaO. The pressure was varied from 0.8 mm. Hg to 0.0009 mm.; and the p.d. from 5 to 3200 volts. Curves were obtained both with and without the presence of Hg vapour. At the higher pressures there is a rise of p.d. with increase of current. This gives way to a constant p.d. for various currents as the temperature of the Wehnelt kathode is raised by the auxiliary current. This happens the sooner, the lower the pressure. At very low pressures (0.0006 mm.) there is at first a decrease of p.d. with increase of current. In extreme vacua the limiting state would probably be a purely "dependent" current conveyed solely by the electrons liberated from the heated Wehnelt kathode. E. E. F.

1318. *Conduction of Electricity in Extreme Vacua.* J. E. Lilienfeld. (Ann. d. Physik, 82. 4. pp. 678-788, June 21, 1910.)—A full account is given of the method of obtaining and keeping a good vacuum, and the discharge tubes used are also fully described. Within the limits of these researches it is found that for current densities which exceed a known minimum value $i = \epsilon v^2$, where ϵ is a factor independent of the form of the tube. The connection between current density and fall of potential is independent of the form of the discharge path. From a max. value for the density of the gas downwards, the characteristic of the discharge is generally independent of the density of the gas. When the gas density is sufficiently small the fall of potential increases as (current)^{2/3}. The general conclusion is arrived at that positive charges exist for which e/m is independent of the nature of the material, also that an extraordinary decrease in the mean free paths of negative electrons takes place in very high vacua, and that this is caused by the passage of the electric discharge. A. E. G.

1319. *Dielectric Cohesion of Argon.* E. Bouty. (Comptes Rendus, 150. pp. 1643-1647, June 20, 1910.)—With argon the determination of the dielectric constant b is very difficult, since the value of the critical field $y = a + bp$ undergoes spontaneous variations even when p the pressure does not vary. In other gases the term a , which depends on the nature of the gas, the nature and the condition of the surface of the flask containing the gas, remains fairly constant; in argon it has values varying from 0 to 800 or 900; but by elimination b works out as being 88. A. D.

1320. *Explosive Potentials.* P. Villard and H. Abraham. (Comptes Rendus, 151. pp. 269-272, July 25, 1910.)—In a preceding paper [see Abstract No. 978 (1910)] it was shown that a p.d. which produces a disruptive spark in free air only gives rise to a positive brush which is sometimes hardly visible when the spark-gap is in dry air deprived of CO₂. This brush, unlike a disruptive spark, does not prevent the p.d. from rising. At a certain potential gradient it disappears, a luminous glow taking its place. This increases

in area until the disruptive discharge takes place. In the previous experiments an electrostatic machine was used. The results of experiments with high alternating pressures of frequency 42 and 500 are now recorded. The spark-gap consisted of a plate and a small ball 5 mm. in diam. The phases of the discharge were easily followed by a stroboscopic arrangement. When the small ball was positive and the potential was increasing, positive brushes were first noticed. These were followed by the anodic glow. With a max. p.d. of 45,000 volts these phenomena were observed with gaps ranging from 8 to 20 cm. At distances less than 8 cm. the anodic glow expanded and produced a disruptive discharge. When the frequency was 500 the phenomena were similar, but the brush discharges were much feebler. It was noticed that a small gap in the circuit—not more than a few tenths of a mm.—favoured the production of the positive brush discharge. At 45,000 volts and a frequency of 42 the following results were obtained: *Without a gap*—(1) From 8 to 20 cm. the anode glow was noticed. (2) At 8 cm. an arc was established. (3) The arc went out when the electrodes were separated to 6 cm. *With a gap*—(1) To great distances positive brushes appeared. (2) At 8 cm. the arc was established. (3) The arc went out at 10 cm. With a Wehnelt interrupter the following phenomena were noticed. With the electrodes far apart (15 cm.) positive brushes appeared. As they were brought closer a torrent of long, wavy sparks appeared, but at 5 cm. apart the sparks disappear completely and are replaced by the positive glow with regular discharges. A gap in the secondary circuit, however, reproduces the positive brushes. The existence of the two kinds of explosive potential probably explains the discrepancies in the results obtained by careful experimenters.

A. R.

1321. *Terminal Potential of a Tesla Transformer*. L. Lauer. (Elektrotechn. Zeitschr. 81. p. 41, Jan. 18, 1910. Extract of Dissertation, Göttingen, 1907.)—Making use of the formulæ and tables given by Drude [see Abstracts Nos. 950b (1904) and 585a (1905)] the author has built a Tesla transformer, and in the Dissertation gives an account of his attempts to measure the potentials at the terminals. A Braun tube is connected to one pole of the secondary, the mid-point is earthed, and the other pole left insulated; the cathode-ray beam is deflected by a magnetic field of known strength. The path of the beam is then given by the expression: $1/r = H\sqrt{e/m2V_0}$, where H is the field strength, $1/r$ the curvature of the path, e/m is the ratio of charge to mass, and V_0 is the p.d. V_0 is the unknown factor in the equation and is determined for the most varied experimental conditions. The highest p.d. between one pole and the mid-point (zero potential) measured in this way was 148,000 volts. A spark-gap placed in parallel with the Braun tube allowed of the dependence of the sparking distance upon the voltage at these high frequencies being determined, but the values found are not stated in the Abstract.

L. H. W.

1322. *Diffraction of Electric Waves*. H. Poincaré. (Lumière Électr. 10. pp. 865-869, June 19; 887-894, June 25, and 11. pp. 7-12, July 2, 1910.)—The author assumes in the first place that every function to be dealt with is capable of expression as the real part of $Ae^{i\omega t}$, where A is independent of the time, and the real and imaginary portions of ω respectively represent the period and damping of the oscillation. Now the damped electric wave emanating from an oscillator cannot be expressed in the form $Ae^{i\omega t}$, where ω is purely imaginary; for such a wave must have had a beginning, and must

therefore be represented by a discontinuous function $F(t)$ which vanishes for t less than 0, and is equal, say, to $e^{-\mu t}$ for t greater than 0. This function can be developed in a Fourier series of the form—

$$F(t) = \int_{-\infty}^{+\infty} e^{i\omega t} \phi(\omega) d\omega,$$

where ω is a real quantity. He therefore assumes ω to be always real in the functions to be considered. It therefore follows that any such electric wave excited by an oscillator must be capable of representation as a continuous spectrum. Much greater wave-lengths will therefore come into consideration than in the view where the wave-length λ is treated as simply the real part of a complex quantity ω . It is simply shown, moreover, that the intensities of such waves remain sensible in the case of wave-lengths very much greater than λ , giving rise to much greater diffraction than could arise if the wave-length λ only had to be considered. The definite problem considered is the diffraction by the earth's surface, considered as the surface of a perfectly conducting sphere, of the waves excited by a rectilinear oscillator so placed that its axis produced would pass through the earth's centre. The field will then be one of revolution, being symmetrical about the radius passing through the position of the oscillator. The papers are devoted to transforming the general equations of the electromagnetic field into forms convenient for the solution of this problem and the development of the requisite analysis. The solution is expressed, not in terms of Bessel functions, but in terms of series closely analogous to them which are here developed. The conclusion of the analysis is that, for points on the earth's surface which are not too near to the oscillator, the amplitude of the waves is sensibly proportional to $e^{-m\phi}$, where m is a numerical factor, and ϕ is the angle which the radius through the point in question makes with the radius through the oscillator. The author is very doubtful as to whether further experimental measurements may be expected to show that this diffraction is sufficient to account for the observed results, or whether it may not be necessary to supplement the diffraction by the results of successive reflection between the earth's surface and the higher, more ionised, layers of the atmosphere. The known variation in ionisation during the day and night, taken in combination with the noteworthy differences in the range of transmission during the day and at night, appear to point to the latter alternative.

G. W. DE T.
 1923. *Bending of Electric Waves Round a Large Sphere.* II. J. W. Nicholson. (Phil. Mag. 20, pp. 157-172, July, 1910.)—In Part I. [see Abstract No. 1180 (1910)] the extent of the region of transition from brightness to shadow, when a radial oscillator is placed close to the surface of a perfectly conducting sphere, was examined. The present instalment is devoted to a discussion of the nature of this region. Ordinary considerations suggest the existence of diffraction bands of alternate maximum and minimum intensity. At an early stage in the analysis it is found, however, that the shadow produced by the sphere is much too complete to admit of diffraction as an adequate explanation of the experimental results, except in the case of very small orientations, and this is fully confirmed by the further development of the analysis, which shows the absolute impossibility of accounting for these results by diffraction merely. For surface-points the results here obtained are in accordance with those obtained in Poincaré's revised investigation, which was referred to in Part I.
 G. W. DE T.

1324. *Transmission of Electric Waves through Resonator Gratings.* F. C. Blake. (Phys. Rev. 30, pp. 674-697, June, 1910.)—A reply to a paper by Schaefer (see Abstract No. 1208 (1907)). The latter had insisted on the use of diaphragms in such work on electric waves. The experiments of a former paper [Abstract No. 100 (1907)] are therefore repeated, diaphragms, of which the openings are varied being placed in front of the oscillator and receiver mirrors. With or without these diaphragms "extra transmission" [see (6) in Abstract No. 100 (1907) and also Abstract No. 974 (1910)] is obtained. It varies in amount from 5 to 40 per cent. according to the disposition of the apparatus. Without diaphragms and, in some cases, with diaphragms the amount of energy reaching the receiver depends on the position of the resonator screen, maximum effects being obtained when the screen is placed midway between oscillator and receiver. Subsequent experiments indicate that diffraction around the glass of the resonator screen and from the openings of the diaphragms plays a considerable part in these effects. Extra transmission is, however, obtained in every case. The conclusion reached is that in work of this kind the use of diaphragms is *not* justifiable. T. P. B.

1325. *Null-method of Determining the Constants of Oscillatory Circuits.* L. Kann. (Phys. Zeitschr. 11, pp. 508-507, June 1, 1910.)—Two coupled oscillatory circuits are in resonance, if $\int_0^\infty i_1 i_2 \cdot dt = 0$, where i_1, i_2 are the momentary currents in the circuits. In this paper a piece of apparatus is described which indicates when the integral is zero, thus giving a null-method of determining resonance, &c. It consists of two small air-thermometer globes joined by a bent capillary tube, in which is a drop of alcohol serving as index of any difference of pressure in the two globes. Another tube with stop-cock connecting the globes serves to equalise the air-pressure. In each globe are two heating wires, $h_1 h'_1, h_2 h'_2$, and all four wires are as nearly as possible the same in every respect. To these wires are connected two circuits of high impedance, in which currents are induced by oscillations in the two circuits which are to be brought into resonance. The current i_1 induced by the primary circuit is sent through h_1 and h_2 , while that, i_2 , induced by the secondary is sent through h'_1 and h'_2 . Thus the quantities of heat are proportional to $(i_1 + i_2)^2$ and $i_1^2 + i_2^2$ and the difference is proportional to $i_1 i_2$. When the index does not move, $i_1 i_2 = 0$ and the circuits are in resonance. Capacity and self-induction may thus be readily determined. The logarithmic decrements λ_1, λ_2 are determined as follows: With the two circuits in resonance, i_1 is sent through h_1 and i_2 is sent through h_2 , and the coupling with the oscillatory circuits is adjusted until the index shows no displacement. The wire h'_1 is put in parallel with h_1 and the heat developed in the globe is halved. The heat developed in the other globe is then halved by adjustment of the variable capacity in the secondary circuit to values c_1 and c_2 on each side of the resonance value c_r . Then $\lambda_1 + \lambda_2 = 1.57 (C_1 - C_2)/C_r$. Diagrams of the connections are given and also photographs of the instrument as actually constructed. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1326. *Temperature Coefficients of Resistance of Alloys.* A. A. Somerville. (Phys. Rev. 30, pp. 582-584, April, 1910. Abstract of paper read before the Amer. Physical Soc.)—Curves are given showing the variation of

resistance of samples of Ni, nichrome, W, and Mo with change of temperature. The range of temperature is from 0° to 1060° C. Temperatures are measured by the Pt thermometer, and resistances by a dial bridge. The heating arrangement is a resistance furnace, made by wrapping nichrome ribbon round a porcelain tube. The thermometer is connected to a Callendar automatic recorder. Nichrome is an alloy made by the Driver-Harris Wire Co.; its coefficient is only $\frac{1}{10}$ of that of Ni, and it is suitable in the form of ribbon for furnace manufacture, as it stands a temperature of 1,300° C. and does not oxidize readily. Tungsten and Mo oxidize readily, and must be kept in an atmosphere of nitrogen. The work is to be extended to other materials. H. W. M.

1327. *Portability of Weston Cell.* H. Tinsley. (Electrician, 65, pp. 588-589, July 15, 1910.)—In order to prevent the ingredients of a cell from becoming displaced in transit, drumheads of linen and cork are placed over the solid chemicals. Cells set up in this way do not appear to be materially affected in e.m.f. by the linen screen, and as this at once becomes impregnated with solution, its resistance is kept low. The cells appear to have a very uniform resistance of about 700 ohms. F. E. S.

1328. *Method of Slowly Charging a Leaf-electroscope with Zamboni's Pile.* D. Isitani. (Mathematico-Physical Soc., Tōkyō, Proc. 5, 15, pp. 249-251, April, 1910.)—A great defect in the use of Zamboni's pile for charging an electroscope is the difficulty found in charging it to any desired potential. Methods are described for charging the leaf system slowly, and the following simple apparatus for this purpose is described. Two wires are connected by a bundle of dried cotton threads. To keep the threads dry and make the system retain its form, the whole is sealed up in a small glass tube, the wires projecting. To get a sufficiently small conductivity, silk threads can be employed with the cotton. To charge an electroscope, one of the projecting wires is screwed to a pole of the pile, the other pole of which is earthed. The second wire is then placed in contact with the leaf system. A. E. G.

1329. *Index for Use with Mirror Galvanometers, &c.* W. Volkmann. (Deutsch. Phys. Gesell., Verh. 12, 18, pp. 588-587, July 15, 1910.)—The author describes a method by means of which an opaque index surrounded by a bright disc is reflected upon the graduated scale, instead of the usual bright image of the lamp filaments. From the account given it appears to work extremely well and should be of use for lecture-room demonstrations as well as the more accurate work of the research laboratory. A. E. G.

ALTERNATING CURRENTS AND MAGNETISM.

1330. *New Resonance Phenomena in Alternating-current Circuits.* O. Martienssen. (Phys. Zeitschr. 11, pp. 448-460, May 15, 1910.)—The relation $X = E/\sqrt{R^2 + (1/pC - pL)^2}$ for an alternating-current circuit with capacity and self-induction is true for certain conditions which are not of the greatest practical importance. If, as is usual, the self-induction has an iron core, eddy currents and the variability of the permeability μ , may affect considerably the relation between X and E . In this paper the effect of these two factors is worked out mathematically and the conclusions tested by experiment. The above relation may still be used provided R is replaced by a

1334. *Magnetic Fields Investigated by Oscillograph.* C. Dégutène. (Phys. Zeitschr. 11, pp. 512-517, June 1, 1910.)—A small test-coil in the alternating field to be investigated is connected to a circuit of considerable self-induction, which contains the oscillograph. If the ratio of resistance R of this circuit to its self-induction L is small, then approximately $dN/dt = L \alpha i/dt$. Thus the α -curve given by the oscillograph is similar to the N -curve of the field. The error due to neglecting the term involving R is discussed, and it is shown that, so long as R/L is not > 10 , and the frequency is not < 50 , the error is not greater than the errors which occur in the taking of oscillograms. But if L is not to vary, the condition R/L not > 10 involves the use of too heavy a coil. Thus a coil with an iron core must be used. To avoid error due to variability of permeability the core should be magnetised to the point of max. permeability by an auxiliary current. In any case, when a coil without an iron core is used and R/L is > 10 , the curve can be easily corrected. Oscillograms are given.

1335. *Magnetisation of Alloys in Relation to their Composition and Temperature.* K. Honda. (Ann. d. Physik, 82, 5, pp. 1008-1026, July 8, 1910.)—The method of investigating the temperature effect was that of Lewkonja [Abstract No. 809 (1909)], in which a small stove is used within the magnetising coil. The test-pieces were small, having diam. 1.8 cm. and length 1.5 to 2.0 cm. Curves are given showing the effect of composition and temperature on alloys of Ni-Cr, Co-Cr, Fe-V, Ni-Sn, Ni-Al, Mn-Sb and Mn-Sn; these confirm Tammann's laws of magnetisation of alloys [Abstract No. 905 (1909)]. Further, it was shown that in one case, Mn-Sn, the remanent magnetism depended on the mode of crystallisation, and that the paramagnetism and ferromagnetism of certain crystalline forms are distinct; in consequence, the linear relation between paramagnetism and concentration for an alloy consisting of two forms of crystals is disturbed if a new form is substituted for one of the original crystalline forms.

1336. *Magnetic Properties of Silicon-iron Alloys.* M. Otto. (Deutsch. Phys. Gesell., Verh. 12, 5, pp. 240-250, March 15, 1910. Extract from Inaug. Dissertation, Halle, 1909.)—Investigations were made on four alloys of iron and silicon (0.61, 1.94, and 4.55 per cent. Si), in order to determine the influence of Si on the magnetic properties of iron. Special study was made of the dependence of the magnetic properties of the alloys on the number of magnetic cycles through which they have been carried, and also of magnetic viscosity. The tests were made ballistically on a number of circular stampings, 12 cm. in diam., 0.5 cm. broad, and 0.8 cm. thick, wound with primary and secondary coils. The B - H and μ - B curves show that in weak fields the alloys are more permeable than iron alone, and the order is that of the percentage composition. The reverse is the case in stronger fields. The same holds good for residual magnetism; below $H = 2$ iron shows less, and above, more, residual magnetism than the alloys. The effect of the number of cycles was then examined, $100 (B_{\max.} - B_{\max.})/B_{\max.}$, i.e., the difference between the max. value of the induction after n cycles and that after a single cycle, was measured for different numbers of cycles and different values of the field strength for each of the samples. It is found that this quantity is very considerably diminished by the addition of Si; that the region in which it differs from zero is more confined; and that with decrease in Si its greatest value is found nearer the region of lower field strength. This does not hold for strong fields ($H = 85$), for which the quantity is almost always positive

and not dependent in any simple way on the number of cycles or composition of the material. Coercive force and hysteresis loss are both diminished by the addition of Si. In order to measure magnetic viscosity the secondary circuit was closed by means of an Atwood's machine a fraction of a second after the magnetising circuit. Viscosity reaches its highest value where the permeability is high. The curves obtained by plotting ballistic kick against time are characterised by a sharp falling off, followed by a slow creep; in the case of the alloy containing 4.55 per cent. Si this creep is absent.

H. W. M.

1937. *Magnetic Results obtained in 1909-10 by the Survey-yacht "Carnegie."*

L. A. Bauer and W. J. Peters. (Terrestrial Magnetism, 15, pp. 57-82, June, 1910.)—This paper gives the complete results obtained in the 8000-mile cruise from Long Island to England, Madeira, the Bermudas, and back to New York. Extensive details are given to show the absence of appreciable deviation corrections, and the perfection of the instrumental appliances and the methods of observation. Under favourable conditions the absolute accuracy of the sea magnetic observations did not fall far short of that attainable on land. Tables are given exhibiting the values of the magnetic elements at 152 points along the track. It is found that the charts giving the direction of the compass issued by the British Admiralty and by the U.S. Hydrographic Office show too small west magnetic declination along the track of the *Carnegie* from Madeira around to Bermuda and Long Island, and from thence to a point off Cape Race, the average correction approximating $\frac{1}{4}$ of a degree. The German chart shows the same systematic error in an even more pronounced manner. For the track from St. John's to Falmouth, the corrections for all charts are, in general, reversed in sign, showing now too high values of west declination for long stretches by about $\frac{1}{4}$ of a degree. From Falmouth to Madeira the charts are more accurate. It appears that the systematic chart errors are largely due to erroneous corrections allowed in the construction of the charts for the secular variation. The magnetic inclinations given on the British Admiralty charts are generally accurate to within 2 degrees. The errors in the German charts are larger. In both cases the values of H are accurate to about 2.5 per cent. on an average.

A. D. R.

1938. *Propagation of Magnetic Storms over the Earth's Surface.* R. L.

Faris. (Terrestrial Magnetism, 15, pp. 98-105, June, 1910.)—The author discusses the times of occurrence of 15 abruptly commencing magnetic storms, each recorded at 5 observatories. The results show that the occurrences were not simultaneous at the stations, but that the average time required if the magnetic impulse encircled the globe would be about $8\frac{1}{2}$ min. H observations gave 9.5 min., V observations 8.6 min., and D (decl.) observations 8.8 min. [see Abstract No. 998 (1910)]. The storm also commenced in the different elements at different times. H was generally first disturbed. D was affected on the average 0.4 min. later, and V 1.9 min. later than D.

A. D. R.

1939. *Origin of Terrestrial Magnetic Storms.* L. A. Bauer. (Terrestrial

Magnetism, 15, pp. 107-128, June, 1910.)—The first question which arises is whether the external disturbance-current system is directly or indirectly due to solar emanations or radiations. If directly, one is led to adopt some emission theory such as that of Arrhenius or Birkeland-Störmer's kathode-ray theory. In both cases, the upper electric currents would be due to moving negatively

charged particles, the precise paths and circuits being dependent upon the angle of incidence of the electrons when striking the earth's magnetic lines of force, and upon the magnitude and character of the deflecting magnetic and electric forces. Analysis of the magnetic disturbance of 1902, May 8, shows that the flow of electricity was eastwardly around the earth for negative charges. Hence if the disturbance was due to cathode rays deflected by the earth's field into approximately circular paths, the source of the cathode rays cannot have been solar. On the other hand, if the cathode rays were of terrestrial origin, the radius of the circular path would be 2,800,000 miles, which is absurd. One is therefore compelled to abandon the idea of a direct solar action. If the electric currents are due to an indirect effect of the sun, then most likely we should look to an ionising effect of solar radiations and emanations, and thus to an increased conductivity of the air. Since an electric field always exists in the upper atmosphere, any alteration in the electrical conductivity of the regions in which these currents exist is accompanied by a flow of electricity. Thus a solar emanation might start off a magnetic disturbance, while the actual energy required would be supplied by the earth's own forces already in existence and *in situ*, and need not be very large. Electric currents resulting from the ionisation of the air and the ensuing motion of ions would, if travelling at a height of 45 miles or somewhat less, have a velocity of nearly 7000 miles per min., and would thus encircle the earth in 8½ min. If the currents travelled lower they would have a greater magnetic effect, but smaller rate of progression. [See Abstracts Nos. 998, 999 (1910).] A. D. R.

1340. *Rotary Magnetic Disturbances.* R. B. Sangster. (Roy. Soc., Proc. Ser. A. 84, pp. 85-92, July 8, 1910.)—On the occasion of a brilliant display of aurora, some apparently rotary movements of the corona suggested to the author the possible existence of similar changes of direction in the total magnetic force during the time of disturbances. The information has been obtained from the Greenwich Registers for the period 1900-7, and especially that on Oct. 12, 1908. Diagrams are given showing the results of plotting the variations in direction of the total force, indicating that the movement is almost wholly rotary and anticlockwise in direction, the several convolutions differing considerably in size and time rate. Closer scrutiny of the curves showed that rotations opposite to the above were also in evidence; and then it was found, on consulting more data, that the anticlockwise rotations all occurred before midnight, and the clockwise rotations after midnight. All the storms during the period 1900-7 were then plotted according to the time of day and direction of rotation, and very interesting coincidences were at once noticeable. The most remarkable feature is the entire absence of positive or clockwise rotations during the hours 16-21 (afternoon), while the negative rotations rise to a maximum at 20 hours (8 p.m.), and the positive rotations are most numerous about 2 a.m. From 6.30 a.m. to 9 a.m. is the only period of the day showing an entire absence of negative rotations. C. P. B.

REFERENCES.

1341. *Electromagnetic Mechanics.* G. Nordström. (Phys. Zeitschr. 11, pp. 440-445, May 15, 1910.)—A highly analytical treatment of electromagnetic mechanics from the standpoint of Minkowski's relativity principle. [See Abstract No. 2123 (1909).] E. H. B.

1342. Electric Dust Figures on Insulators. G. Quincke. (Ann. d. Physik, 82, 5, pp. 889-940, July 8, 1910.)—Continuation of the work referred to in Abstract No. 1004 (1910). The paper is difficult to abstract briefly as the results are given in tables and figures occupying a dozen pages. E. H. B.

1343. Photo-electric Effect with Zinc in Hexane. G. Jaffé. (Phys. Zeitschr. 11, pp. 871-875, July 1, 1910.)—The photoelectric effect was measured with Zn in hexane, using a mercury arc lamp as source of ultra-violet light. The effect is of the order of one-thousandth that observed with air. E. C. C. B.

1344. Frequency of Oscillations in Lightning. F. Emde. (Elektrotechn. Zeitschr. 31, pp. 675-681, July 7, 1910.)—Discusses, on the electromagnetic theory, the problem of an oscillatory lightning discharge between a cloud and the earth and treats the fundamental oscillation and "overtones." E. H. B.

1345. Arrangement of Experimental Electrical Circuits for Laboratories. W. P. Steinthal. (Inst. Elect. Engin., Journ. 45, pp. 274-292, June, 1910. Abstracts in Electrician, 65, pp. 422-426, June 24, 1910. Elect. Engin. 46, pp. 83-88, July 22, 1910.)—Illustrated.

1346. Electric Resistance of Alkaline Metals. L. Hackspill. (Comptes Rendus, 151, pp. 305-308, July 25, 1910.)—Gives some experimentally-obtained values for the electric resistances of cesium, rubidium, potassium, and sodium at temperatures ranging from 116° down to -190° C. Most of the results are below those obtained by Guntz and Broniewski. Fuller details are to appear later. E. H. B.

1347. Two Relations in Magnetism. R. A. Houstoun. (Roy. Soc. Edinburgh, Proc. 30, pp. 457-460, 1909-1910.)—A new and short proof is given of the two theorems for a ferromagnetic hysteresis-free wire, (1) that according as B increases or diminishes with temperature, so the temperature will fall or rise with increase of H , and (2) that if B increases when the wire is stretched, the wire will elongate on magnetisation, and vice versa. A. D. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY

1348. *Paper Sensitive to Ultra-violet Light.* C. Schall. (Chem. Zeit. 84, p. 267, 1910.)—The use of paper which has been soaked in $\text{N}^\circ 4$ phenylenediamine nitrate is recommended. When exposed to light of wave-length 310–296 μ , the paper turns blue.

1349. *Electric Vacuum Furnace.* O. Ruff. (Ber. Deut. Chem. Gesell. 43, pp. 1564–1574, 1910.)—An electric furnace is described which may be used either as a resistance or an arc furnace. It is so arranged that it can be filled with a gas other than air, and it may be worked at pressures varying from 8 mm. to 1 atm. The wall of the furnace contains a quartz window, so that the temperature may be taken by means of a Wanner pyrometer. Temperatures of 1000–2700° can readily be obtained in a few minutes, and the furnace will withstand temperatures of 2000–2200° for several hours. The power required varies from 200 amps. at 15 volts to 700 amps. at 41 volts. Vanadium (98–99 per cent.) was readily obtained by the reduction of vanadium trioxide with carbon. The following melting-points were determined: Pt, 1745–1755°; Mo, 2110°; Ir, 2210–2225°; kaolin, 1912–1918°; W (99.2 per cent.), 2675°. Titanium containing 5 per cent. of carbon could not be melted completely at 2700°. The oxides of Al, Mg, and Ca were found to be more volatile and fusible than hitherto supposed. At low pressures (8 mm.), and with small quantities of substance, they were completely volatile below the melting-point. In nitrogen at atmospheric pressure, aluminium oxide had melting-point 2065°; that of calcium oxide was in the neighbourhood of 2000°, but could not be exactly determined; magnesium oxide vaporised rapidly at 2100°, but the melting-point is certainly much lower than 2500° (compare Arndt, *Chem. Zeit.*, 1906, 30, 211). The furnace was so adapted that the electrical conductivity of these oxides could be measured, and it was found that there is a great increase in the conductivity when fusion takes place.

1350. *Absorption of Hydrogen by Colloidal Platinum and Palladium Solutions.* G. Kernot and E. de S. Niquesa. (Accad. Sci. Fis. Mat. Napoli, Rendiconti, 15, pp. 168–175, 1909.)—Pure colloidal platinum and palladium solutions absorb much larger quantities of hydrogen than are taken up by the metals in any other physical condition, even by colloidal suspensions prepared by chemical means. A rough proportionality is found between the concentration of the colloidal metal and the volume of hydrogen absorbed. The absorption of hydrogen is considerably diminished by the presence of gum, dextrin, or albumin, but is not sensibly influenced by sucrose.

1351. *Phenomena observed on Mixing Liquid Air with Water.* P. F. W. Weimarn. (Journ. Russk. Fizik.-Chimichesk. Obščestvo, 42, pp. 280–292, 1910.)—When water is poured on to the surface of liquid air containing a large excess of oxygen, it does not solidify immediately, but at first assumes a semi-solid consistency. When liquid air is poured into water, the bluish drops in some cases fall to the bottom, and in others rise to the surface, and

become surrounded by atmospheres of gaseous air and thin elastic scales of ice. The water finally solidifies to a turbid, porous system; so that ice, as well as any other substance, for example, barium sulphate, may be obtained as precipitates of varying form and degree of dispersion, according to the rapidity of condensation. Condensed gases are very suitable dispersive media for obtaining such suspensions. T. H. P.

1352. *Preparation of Pure Argon and Nitrogen.* F. Fischer and O. Hähnel. (Ber. Deut. Chem. Gesell. 43, pp. 1445-1447, 1910.)—A special apparatus is described for the purification of crude argon (obtained by the action of calcium carbide on air) from gases other than those of the argon group. The density of crude argon, purified in the above apparatus, was 19.945, agreeing with the value (19.940) obtained by Ramsay and Travers; that of nitrogen was 14.018. During the circulation of the argon, intensive phosphorescent effects were noticed, being the more pronounced the purer the argon. No such effects were observed in the case of nitrogen. T. S. P.

1353. *New Experiments on the Combining Capacity of Argon.* F. Fischer and F. Schröter. (Ber. Deut. Chem. Gesell. 43, pp. 1442-1454, 1910.)—The apparatus used by Fischer and Ilievici [Abstract No. 576 (1909)] for the production of an arc in liquid argon has been improved so that it is perfectly gas-tight; it retained the highest vacuum for 48 hours, and after working with it for a year the argon used remained quite pure. Special arrangements were also devised for regulating the distance apart of the electrodes, for under-cooling the liquid air used to condense the argon in such a way that fractional distillation of the nitrogen did not take place, and for maintaining an arc between metals which either did not disintegrate or only disintegrated with difficulty. Experiments were carried out with 45 metals, using argon purified according to the method described (*loc. cit.*). Some of the metals disintegrated with the formation of a black powder [see next Abstract], but the majority did not disintegrate. With the exception of Groups I. and VII. of the Periodic Table, the metals which did not disintegrate are contained in the left-hand column (sub-group) of each group, the metals in the first two horizontal rows being counted as belonging to the left-hand column. The metals which disintegrated are those in the right-hand column. None of the metals of the Pt and Fe groups disintegrated, those investigated being Fe, Co, Ni, Pd, Ir, and Pt. When the metal did not disintegrate, the arc formed consisted of incandescent argon, and had a very high resistance; it was also rich in ultra-violet rays. T. S. P.

1354. *Modifications of Metals Resulting from Electrical Disintegration in Liquid Argon.* F. Fischer and F. Schröter. (Ber. Deut. Chem. Gesell. 43, pp. 1454-1464, 1910.)—When an arc discharge takes place between metal electrodes in pure liquid argon, compounds with argon are not formed. In no case could it be proved that they have a momentary existence, even at the temperature of liquid air. If it does so happen that they exist, they must be far more explosive than cadmium nitride. Owing to the disintegration, a number of metals were obtained in a new form. Lithium and sodium were obtained as brown, and potassium, rubidium, and caesium as blue, relatively stable powders. The lithium powder had a density approximately the same as that of liquid argon ($D=1.2$); at 20° Li has $D=0.584$, so that the density increases enormously when the temperature falls to -188° . Zinc and Cd gave deep black modifications, which were only stable at the temperature

of liquid air. Mercury gave a black powder which dissolved in the excess of Hg when the temperature rose. Copper did not disintegrate, Ag only to a very slight extent, and Au slightly more than Ag. The disintegrated Au was dark brown by reflected, and green by transmitted light. Zinc, Sn, In, and Mn gave pyrophoric powders. Bismuth gave a deep black powder, which gradually became grey, and at the same time more dense at room temperature, denoting a change from the amorphous to the crystalline form. Arsenic and Sb gave black powders which did not contain any of the yellow modifications, although the experiments were carried out under exclusion of daylight. None of the finely-divided powders obtained absorbed argon at room temperature; in the case of Zn, absorption did not occur even at the temperature of liquid air. This is in marked contrast with the behaviour of finely-divided charcoal. T. S. P.

1355. *Influence of The Silent Electric Discharge on certain Mixtures of Gases and Vapours.* E. Comanducci. (Accad. Sci. Fis. Mat. Napoli, Rendiconti, 15, pp. 15-17, 1909.)—When a mixture of oxygen and an oxidisable substance is subjected to the action of the silent discharge, for instance, by being passed through an ozoniser, the substance undergoes more or less oxidation, no more ozone being formed [compare Losanitsch, Abstract No. 518 (1908); Löb, Abstract No. 514 (1908)]. Thus water is formed from oxygen and hydrogen when these are in almost equal proportions, or when the latter predominates, but if the oxygen is in excess, water and ozone are formed, and not hydrogen peroxide. Chlorine or hydrochloric acid and oxygen yield hypochlorous anhydride or acid, the amount of the latter being, in one instance, 6.59 per cent. of that of the HCl taken. Mixed with oxygen, methyl and ethyl alcohols give the corresponding aldehydes; ethyl ether, acetaldehyde and paraldehyde give acetic acid, and formaldehyde, formic acid. The hydrogenating power of hydrogen is increased by the dark discharge; thus a good yield of HCl is obtained from hydrogen and chlorine, whilst acetaldehyde and hydrogen give ethyl alcohol. Carbon disulphide and acetone are not oxidised by this method; ammonia yields traces of hydroxylamine, but no hydrazine or nitrous acid; CO and Cl do not react. T. H. P.

1356. *Action of Ultra-violet Rays on certain Sugars.* H. Bierry, V. Henri, and A. Ranc. (Comptes Rendus, 151, pp. 816-819, July 25, 1910.)—Aqueous solutions of carefully purified *D*-fructose (identical with levulose), are placed in quartz vessels of 80 cm.³ capacity and exposed to the radiations of a mercury arc, at about 15° or 65°C. The 87 cm.³ of gas liberated in 24 hours at 15°C. from 25 cm.³ of an 8 per cent. solution, were essentially CO, further CO₂ and formaldehyde; the remaining solutions still contained some levulose, which was afterwards entirely decomposed by fermentation. The gas liberation commenced after about 15 min. The higher temperature accelerated the decomposition by the ultra-violet radiations. A ketose has thus completely been broken down into CO and formaldehyde simply by radiations, without the action of ferments or chemical agents—the first example of a complete degradation of this kind. In similar experiments with aldoses (sugar of the aldehyde type, glucose and others) only very little gas was liberated. H. B.

1357. *Decomposition of Water-vapour by the Brush Discharge.* M. Kernbaum. (Comptes Rendus, 151, pp. 819-822, July 25, 1910.)—The brush discharge is passed from a Pt point, joined to the negative pole of a

Wimshurst machine, to a Pt disc, 5 mm. in diam., at a distance of 5 cm., through saturated steam. The drawn-out Pt point has to be renewed after each experiment. The gas pressure rises, partly owing to the rise of temperature, for about 15 min., when equilibrium is established according to the reversible reaction $2\text{H}_2\text{O}_2 \rightleftharpoons 2\text{H}_2\text{O} + \text{O}_2$. That other observers have not noticed the excess of hydrogen is ascribed to the fact that the peroxide is decomposed above 60° . The effect of the brush discharge is analogous to that of ultra-violet rays and of β -rays, previously studied by the author.

1358. Chemical Effects of the Silent Discharge. A. Moser and N. Ingarišew. (Zeitschr. Elektrochem. 16, pp. 618-620, Aug. 1, 1910.)—The publication of the experiment of Smits and Aten induces the authors to publish the results of their incomplete investigation carried out at Karlsruhe and Moscow. They use a Siemens ozoniser with a Koch-Sterzel transformer, and determine the phase-lag after Dolezalek. In the decomposition $\text{CO} \rightarrow \text{CO} + \frac{1}{2}\text{O}_2$ traces only of ozone are observed (contrary to Brodie), and the electric energy consumed is only $\frac{1}{10}$ or $\frac{1}{15}$ of that of Faraday's law. The equilibrium established in mixtures of $\text{CO} + \text{O}$ depends upon voltage, electrode distance, and temperature; presence of small quantities of chlorine retards the decomposition and the formation of CO , considerably. At 14,000 volts the current decomposes only 1 per cent. of the HCl into $\text{H} + \text{Cl}$. The process $\text{SO}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{SO}_3$ is irreversible, contrary to photochemical oxidation; so long as SO_2 and O_2 are present, this reaction takes place exclusively; the yield is from 8 to 14 gm. SO_3 per kw.-hour. SO_2 splits into sulphur and a peroxide, S_2O_7 (?). A mixture of $\text{HCl} + \text{O}$ reacts according to the Deacon process: $4\text{HCl} + \text{O}_2 \rightarrow 2\text{H}_2\text{O} + 2\text{Cl}_2$; 95 per cent. of the HCl is decomposed, and the yield is 12 gm. Cl per kw.-hour.

1359. Phosphorus Compounds of Cobalt. S. Žemčuzny and I. Schepeleff. (Jurn. Russk. Fizik.-Chimičesk. Obščestva, 41, pp. 862-875, 1909.)—The authors have investigated the melting-point curve of alloys of cobalt and phosphorus, and also the microstructure of several of the solidified products. The results obtained indicate the existence of dicobalt phosphide, Co_2P , which has a hardness of about 6, those of Co and P being 4 and 0.5 respectively; this increased hardness may be connected with the considerable contraction which occurs on formation of the compound. The values of D are for Co_2P , 6.3-6.6; for Co , 8.5-8.9; and for P , 1.9-2.3. The compound exhibits magnetic properties, which are less intense than for Co or the alloys intermediate to Co and Co_2P . Increase of the proportion of P beyond that corresponding with Co_2P leads to the formation of non-magnetic compounds, such as Co_3P_2 .

1360. Manufacture of Cementation Steel. Specific Functions of Gaseous and Solid Cementation Agents. E. Giolitti and L. Astorri. (Gazzetta Chim. Ital., 40, 1, pp. 1-20, 1910.)—Cementation of steel by means of mixtures of carbon monoxide and benzene vapour shows that small proportions of the hydrocarbon increase the concentration of the carbon in the outer zones of the steel beyond the value corresponding with the equilibrium between carbon monoxide and dioxide and carbon dissolved in γ -iron. This rise in the concentration of carbon increases with the proportion of benzene when the latter is small, but for larger proportions of benzene the velocity of decomposition exceeds that of solution: the carbon then forms a layer on

the surface of the steel, and its concentration in the outside layer attains the value reached with solid cementation media; the concentration in this outer layer can be varied by altering the composition of the gaseous mixture. Cementation by carbon monoxide and carbon together results in the addition of the separate actions. Also, when finely-powdered charcoal and steel, almost free from carbon are brought into intimate contact at 1000° in a vacuum, the carbon dissolves, and in an atmosphere of nitrogen at 1000° , solid carbon produces cementation, which diminishes towards the interior of the steel. Charpy's results (Rev. de Metallurgie, May, 1909) are criticised. [See also Abstract No. 824 (1909).] T. H. P.

1361. *Phosphorus Compounds of Iron.* N. S. Konstantinow. (Jurn. Russk. Fizik.-Chimichesk. Obschestva, 41, pp. 1220-1240, 1909. Zeitschr. Anorg. Chem. 66, 8, pp. 209-228, April 11, 1910.)—The alloys of phosphorus and iron were divided by Stead (Iron and Steel Inst. Journ. 58, p. 60, 1900) into five classes according to their phosphorus content. These results were confirmed by Saklatwalla [Abstract No. 1874 (1908)], who gave a melting-point diagram for these alloys. The author's investigations of Fe-P alloys containing up to 21.0 per cent. (82.4 atom, per cent.) of phosphorus show that the solidification-point diagram consists of three branches: (1) AB, falling from 1514° , the melting-point of iron, to 1020° , corresponding with 10.2 per cent. Fe; (2) BC, rising continuously from B to C, and corresponding with the separation of crystals of the phosphide Fe_3P . The separate solidification curves exhibit two halts, one showing a regular rise corresponding with the separation of crystals of the phosphide, and the other at a constant temperature corresponding with separation of the eutectic and gradually diminishing in magnitude as C is approached. Micrographic examination of these alloys shows the presence of rhomboidal plates of Fe_3P surrounded by the eutectic; (3) CD, rising at first rapidly and afterwards more slowly to the point D, corresponding with the phosphide Fe_3P [compare le Chatelier and Wologdine, Abstract No. 2187 (1909)]. A list is given of the known phosphides, arsenides, and antimonides of the metals of the iron series of the eighth group in the periodic system. T. H. P.

1362. *Hardness of Steels at High and Low Temperatures.* F. Robin. (Rev. de Metallurgie, 6, pp. 162 and 180, 1909. Metallurgie, 7, pp. 835-838, June 8, 1910. Abstract.)—The author has extended his work [Abstract No. 596 (1909)] to the study of the hardness of special steels at high temperatures and of both carbon and alloy steels at low temperatures down to -165°C . Results are plotted in the form of temperature-hardness curves; these show that hardness decreases with rise of temperature and increases with falling temperature, somewhat slowly at the beginning but afterwards more rapidly. Molybdenum appears to have the greatest effect in maintaining the hardness of special steels at elevated temperatures, after which follow tungsten and vanadium. Experiments on the effect of low temperatures on austenitic steels show that the change of hardness is proportional to the amount of austenite present, and is an indication of the change of structure. F. C. A. H. L.

1363. *Fusion Diagram of the Iron Sulphide-Iron System.* K. Friedrich. (Metallurgie, 7, pp. 257-261, May 8, 1910. Communication from the Jubiläums-Stiftung der deutschen Industrie.)—The author, has repeated the work of Treitschke and Tammann [Abstract No. 1484 (1906)] under similar conditions with the exception that pure sulphurised materials were used and the melts were not carried out in a nitrogen atmosphere. The diagram obtained differs

from the ideal one depicted by Treitschke and Tammann in that it shows no limited miscibility in the liquid and that the arrest-points of iron are not caused to coincide by the addition of FeS. Iron sulphide melts at 1171°C , iron at 1527°C , and the two branches of the curve unite in a eutectic point at 988°C and a concentration of 86 per cent. FeS. There is only a very limited range of solid solutions at each end of the series. The arrest-points in pure iron are somewhat lowered by the addition of FeS but are not caused to coincide. A row of slight arrests occurring between 1800 and 1400°C are ascribed to the effects of impurities. The paper is illustrated by six photomicrographs confirming the above conclusions. F. C. A. H. L.

1384. *Relationships between Freezing-point Depression, Ionic Concentration and Conductivity of Electrolytes.* J. B. Goebel. (Zeitschr. Phys. Chem. 71, 6, pp. 862-866, March 11, 1910.)—The relationship between concentration and freezing-point depression for cane sugar is given by the formula $C = 0.705 \log(1 + \Delta) + 0.24\Delta + 0.004\Delta^2$. It is assumed that this formula holds good for all aqueous solutions and can be used to calculate the concentration of the ions or molecules in any aqueous solution. When this is done it is found that the dissociation-constants deduced from the freezing-points are fairly steady for solutions of various electrolytes at concentrations up to 0.6N. The mean values found were:—

NaCl	KCl	KBr	LiCl	HNO ₃	HCl	KOH
0.220	0.205	0.201	0.263	0.250	0.307	0.188

If these values are taken it is found that the molecular conductivities can be calculated with very fair accuracy up to normal concentration. The method is also applied to calculate the two dissociation-constants of ternary electrolytes, as follows:—

	MgCl ₂	CaBr ₂	CaCl ₂	SrCl ₂	BaCl ₂	HSO ₄
$\lambda_1 =$	10.0	10.0	5.91	5.0	8.0	0.45
$\lambda_2 =$	0.152	0.150	0.109	0.086	0.080	0.172

In this case also the molecular conductivities can be calculated up to normal concentration from the law of mass-action. T. M. L.

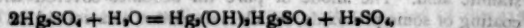
1385. *Influence of Vapours on Ionic Mobility in Air.* K. Przibram. (Akad. Wiss. Wien, Sitz. Ber. 118, 2a, pp. 1419-1438, Dec., 1909.)—Water, the alcohols, fatty acids, and chloroform decrease the mobility of the negative ion more strongly than that of the positive ion; the esters of the fatty acids behave in the opposite way. The hydrocarbons, chlorinated paraffins, and ethyl iodide only retard the ions in so far as they increase the density of the medium. For equal molecular weights the substances which reduce the mobility of the ions most strongly are those which are associated most strongly in the liquid state (water, alcohols, fatty acids, acetone). T. M. L.

1386. *Constitution of the Electric Charge at the Surface of an Electrolyte.* Gouy. (Journ. de Physique, 9, pp. 457-468, June, 1910.)—The author investigates this subject mathematically, and shows that when an electrolyte is electrified the charge produced cannot be purely superficial. The ions are subjected not only to the electrical action tending to accumulate them at the surface, but also to diffusion forces tending to re-establish homogeneity. He shows that if the kathions have the same valency their concentrations remain

everywhere proportional; and similarly with the anions. But if the ions have different valencies their concentrations in the layers near the surface are greater or less according as their valencies are greater. As the chief result of the investigation the author finds that in liquids only slightly ionised the charge occupies a thickness of several microns. From this it follows that if an insulating sheet of specific inductive capacity K' separates two liquid masses, the capacity of the condenser thus formed will be diminished as if the thickness of the dielectric were increased by $2K'/K$, where K is the dielectric constant of the liquid, and s the centre of gravity of the charge.

1367. Theory of the Oxygen Electrode. Behaviour of Platinum Oxides. G. Grube. (Zeitschr. Elektrochem. 16, pp. 621-632, Aug. 1, 1910.)—The author investigates the potentials, in 2-N H_2SO_4 , of platinum oxides and hydrates, prepared after L. Wöhler, and of Pt electrodes coated with these compounds. The experiments were conducted under F. Foerster; they support some observations of Foerster and Staehelin and differ from some of Lorenz, Hauser, Lauber, and Spielmann [see Abstracts Nos. 945 and 1886 (1909)]; reference is also made to Bornemann [Abstract No. 2150 (1909)] and others. The PtO potential rises slowly to +1.06 volts (against a) in the case of the hydrate with $4H_2O$, and to +1.04 volts for the hydrate $PtO \cdot 2H_2O$; in the latter case the potential decreases again after attaining a maximum. PtO gave an uncertain potential of about 0.9 volt. Freshly prepared PtO has the potential 1.5 volts; when Pt is coated with this oxide the potential decreases steadily under liberation of oxygen to 1.05 volts, without stopping at 1.23, 1.15, or 1.08 volts; anodically-polarised platinised Pt and PtO hydrate behave in the same way. There seems to be a still higher oxide PtO_2 . In the presence of H_2O_2 , especially if concentrated, electrodes of PtO and of PtO_2 are rapidly discharged.

1368. Kathode Equilibrium in the Weston Standard Cell. G. A. Hulett. (Phys. Rev. 30, pp. 648-655, May, 1910.)—In previous articles the author has shown that mercurous sulphate, the depolariser in the Weston cell, is hydrolysed by the solution of cadmium sulphate [see Abstracts Nos. 136 and 1814 (1909)], and in order to account for the slow changes which have been observed in Weston standard cells, he has assumed that this hydrolysis proceeds more rapidly at the surface of the mercury than at any other point in the system. Experimental evidence in favour of this assumption is now brought forward. Two tubes were charged, the one with mercury, mercurous sulphate, cadmium sulphate, and solution in about the proportions used in standard cells, and the other with mercurous sulphate free from mercury, cadmium sulphate and solution. They were then rotated for several days, and at intervals some of the clear solution was removed and tested on a clean mercury surface against a cadmium amalgam, thus forming with it a standard cell. The resulting e.m.f.'s indicate the rate at which hydrolysis, represented by the equation—



is taking place, and show clearly that the above assumption is correct. A diagram is given representing the concentrations of mercurous mercury in a saturated solution of cadmium sulphate as a function of the varying concentration of sulphuric acid, all at 25° C.

T. S. P.

1369. *The Iron-nickel Accumulator. III. The Iron Electrode.* F. Foerster and V. Herold. (Zeitschr. Elektrochem. 16, pp. 461-498, July 1, 1910.)

The experiments were made with two sorts of powdered iron: A, from Kahlbaum, finest grain obtainable, containing 0.08 per cent. Mn, 0.03 Ni, and some oxide; B, much finer-grained iron from Edison and Bergmann (reduced at the low temperature of 480°C . from oxide by hydrogen), with 0.05 Cu, 0.1 Ni, 0.05 graphite, 0.01 Si, and more oxide than A. The powdered iron was mixed with graphite flakes and placed in flat, perforated steel cases (Edison). The pockets were then mounted in rubber stoppers together with two nickel peroxide electrodes, and charged in 28-N. caustic potash. An analytical determination of the iron in the presence of its oxides was effected after J. Weber with the aid of neutral mercuric chloride. The capacity of the B iron was considerably higher than that of the coarser A powder, but this showed less in the more important first step of the discharge. In this step I metallic iron is electromotorically active according to $\text{Fe} \rightarrow \text{Fe}^{++} + 2\text{e}^{-}$ under formation of ferrous hydroxide, the iron having become charged with hydrogen. As the iron turns passive, step I passes into II. In step II the ferrous hydroxide is active according to $\text{Fe}^{++} \rightarrow \text{Fe}^{+++} + \text{e}^{-}$, iron disappears, and oxide is formed. Only a portion of the iron is really concerned in the reactions. The capacity increases with higher temperature; at 75°C . step II vanishes [Kraus confirmed]. The electrolytic reduction of the ferric oxide takes place at first without generation of hydrogen, that of the ferrous oxide always under generation of hydrogen; a large portion of oxide remains unreduced. Excess of iron oxide and discharge at high current density impair step I; addition of finely divided mercury (commercially important) favours the discharge conditions by keeping the iron active, but has no influence on the charge. The efficiency of the iron cell is low, because the ferrous oxide of step I is not, at ordinary temperature, reversibly reducible (but only under generation of hydrogen), and because the charging up of the nickelhydroxide is not reversible either. Efficiency and capacity can be varied at will, the one at the expense of the other. The authors confirm many of the potential determinations of Faust, but differ as to the explanation of step I. [Compare also Abstracts Nos. 2011 (1905), 1247 (1907), and 1845 (1908).] H. B.

1370. *Behaviour of Anodes of Tin in Caustic Soda.* F. Foerster. (Zeitschr. Elektrochem. 16, pp. 599-606, Aug. 1, 1910.)—According to experiments made by H. Goldschmidt and M. Eckardt [see Abstract No. 1945 (1906)], anodically polarised tin dissolves in caustic alkali as a divalent metal, while technically it is deposited as a tetravalent metal in refining. The authors repeat those experiments with similar apparatus but more concentrated solutions. They find that pure tin dissolves indeed as divalent metal, but that the dissolution is soon stopped. The metal turns passive, the potential rises from -0.8 to $+0.8$ volt, oxygen is liberated, and the stannous salt oxidises to stannic salt. Left to itself under exclusion of the air the solution deposits some metallic zinc (especially when warm) in addition to metastannic acid. The anode of pure tin becomes covered with an insoluble coating of some protoxide, which is deposited as a colloid on the anode. On an anode of impure commercial tin this deposit does not settle owing to the anode mud, and the tin dissolves essentially as tetravalent metal. H. B.

1371. *Effect of Pressure on the Electrolytic Rectifier.* A. P. Carman and G. J. Balzer. (Phys. Rev. 30, pp. 776-781, June, 1910. Paper read before

the Amer. Physical Soc., Dec., 1906.)—The authors have photographed a number of oscillograph curves of the alternating current through different electrolytic rectifiers at pressures from 15 cm. up to 21 atmos. and at different temperatures. These curves show that at the higher pressures the rectifying property decreases: at 21 atmos. a cell with Al-carbon electrodes and alum for electrolyte showed about half rectification. The property of rectification is regained when the pressure is reduced. Increase of temperature is also shown to act similarly to increase of pressure, but the cell does not recover its rectifying properties when the temperature is lowered again. Observations were also made on the deposits formed on the electrode. The bearing of these on the theories advanced are briefly discussed. L. H. W.

1372. *Electrolytic Preparation of Hypochlorites.* W. N. Ogloblin. (Jurn. Russk. Fizik.-Chimichesk. Obščestva, 41, pp. 670-679, 1909.)—After reviewing previous work on the electrolysis of sodium chloride solutions, the author describes his own experiments on this subject, the results of which are briefly as follows: Other conditions being constant, the greatest amount of active chlorine is obtained at the ordinary temperature from the most concentrated solution of sodium chloride. As the hypochlorite solutions formed are decomposed by the action of air and light, the greatest yield of active Cl is obtained when the interruption of the current during electrolysis is least. The proportion of active Cl increases with the period of electrolysis. The more the temperature rises in the electrolytic cell, the less is the yield of active Cl. The greater the current employed, the greater will be the active Cl obtained and the less the amounts of salt and current used. The loss of Cl increases with the time of exposure of the solution to sunlight and air. T. H. P.

1373. *Electrolytic Preparation of Rubidium.* G. v. Hevesy. (Zeitschr. Anorg. Chem. 87, 2, pp. 242-247, June 7, 1910.)—Metallic Rb may be prepared by the electrolysis of fused rubidium hydroxide, using a method similar to that of Lorenz for the preparation of potassium, if the anode is also surrounded by a cylinder of magnesite. The current-yield is 80 per cent., the loss being due to (1) the solution of the deposited metal in the fused electrolyte; (2) the reaction $\text{RbOH} + \text{Rb} \rightleftharpoons \text{Rb}_2\text{O} + \text{H}$; and (3) the transference of oxygen through the fused electrolyte, this being the chief factor causing the loss. Rubidium hydroxide has a density of 8.208 at 11°C., melts at $801 \pm 1^\circ\text{C}$., and has a latent heat of fusion of 15.8 cal. per gm. Instead of preparing pure Rb it is much cheaper and simpler to prepare alloys—up to 80 per cent.—of Rb with sodium and potassium by the action of these latter metals on molten, anhydrous rubidium hydroxide. Alloys of caesium and sodium may be obtained in a similar manner from caesium hydroxide. T. S. P.

1374. *Electrolysis of Glass.* A. Heydweiller and F. Kopfermann. (Ann. d. Physik, 82, 4, pp. 789-748, June 21, 1910.)—The glass to be electrolysed was in the form of a tube, 1-2 mm. thick in the walls, and closed at the bottom end. It dipped into the molten anolyte, which consisted of the salt of the metal that was to be introduced electrolytically into the glass, and was partially filled with a molten mixture of potassium and sodium nitrates, which acted as the catholyte. The voltage used was 220, and the current strength varied from 0.0005 to 0.25 amp.; the experiments lasted from a few min. to several hours. The glass used consisted either of an easily fusible

Thuringian soda-glass, or of a difficultly fusible potash-glass. The results show that the metals which migrate electrolytically into the glass, that is, which dissolve in silicic acid at 250–450°, transform into the colloidal condition. On strongly heating, the nobler metals regain the metallic state, whereas the baser metals are changed into oxides. It is probable that the metal originally present in the glass is also partially changed to the colloidal condition. A large number of metals can be introduced into glass, at temperatures above 200°, either by ordinary diffusion, or, better, by electrolysis in the way already indicated. In the case of Ag and Cu different colours, due to different colloidal modifications, are obtained, the colour obtained depending on the temperature. With Ag a yellow colour is obtained below 280–290° C., and a rose-red above those temperatures. The yellow colour may be changed into the rose-red by heating alone, but the reverse change does not take place on cooling. If the plausible assumption is made that on the introduction of a new kation into the glass the resistance becomes greater or less according as the mobility of the new kation is less or greater than that of the kation displaced, the following order for the mobilities in glass of different kathions is obtained:—

Na > K at 800–400° C.	Cu > Na at 850° C.
Ba > Na at 880–450°	Cu < K at 850–450°
Sn < K at 250–300°	Fe > Sn at 290–380°
Na > Sn > K at 400°	Fe = Na at 400°
Pb > Na at 850–450°	Ag > Na at 280–400°.

In some cases the order varies with the temperature. T. S. P.

1376. *Influence of a Magnetic Field on the Passive State of Iron.* H. G. Byers and M. Darrin. (Amer. Chem. Soc., Journ. 82, pp. 750–756, June, 1910.)—The glass cell containing an iron wire anode and a Pt cathode was placed between the poles of an electromagnet, and the relation between the current density and the voltage determined, both when the magnet was and was not excited. In solutions of nitric, sulphuric, and phosphoric acid, of potassium nitrate and of sodium sulphate the transition-point of passive iron to active iron is a function of the current density, but the transition is retarded by the magnetic field. The results are not affected in any way by the direction of the current through the electromagnet, or by the relative position of poles and electrodes; in no case did the magnet cause a change in the amount of current passing through the electrolyte or in the relative potentials of the two electrodes. The cause of passivity may be found to be due to an altered state of the metal itself, this altered state being analogous to that of a number of magnets, the negative poles of which are all presented to the electrolyte, this orientation being produced by the various agents which cause the passive state. [See Abstracts Nos. 1727 and 2005 (1908).]

T. S. P.

REFERENCES.

1378. *Vanadium.* G. Gin. (Amer. Electrochem. Soc., Trans. 16, pp. 393–473, 1909.)—An exhaustive monograph treating of the whole range of the metallurgy and chemistry of vanadium and its alloys. L. H. W.

1377. *Andrews' Measurements of the Compression of Carbon Dioxide and of Mixtures of Carbon Dioxide and Nitrogen.* Edited by C. G. Knott. (Roy. Soc. Edinburgh, Proc. 80, pp. 1–23, 1909–1910.)